BMJ open

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Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2014-005044
Article Type:	Research
Date Submitted by the Author:	12-Feb-2014
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Primary Subject Heading:	Rehabilitation medicine
Secondary Subject Heading:	Health services research, Sports and exercise medicine
Keywords:	Adherence, Self-report, Exercise, Rehabilitation

A systematic review of measures of self-reported adherence to unsupervised home-based rehabilitation exercise programmes, and their psychometric properties.

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Key words: Adherence, Self-report, Psychometric, Exercise, Rehabilitation

Word Count: 2,674

Abstract

Background
Adherence is an important factor contributing to the effectiveness of exercise-based rehabilitation. However, there appears to be a lack of reliable, validated measures to assess self-reported adherence to prescribed but unsupervised home-based rehabilitation exercises.

Objectives
A systematic review was conducted to establish what measures were available and to evaluate their psychometric properties.

Data Sources
Medline, Embase, PsycINFO CINAHL (June 2013) and the Cochrane library were searched (September 2013). Reference lists from articles meeting the inclusion criteria were checked to ensure all relevant papers were included.

Study selection
To be included articles had to: be available in English; use a self-report measure of adherence in relation to a prescribed but unsupervised home based-exercise or physical rehabilitation programme; involve participants over the age of 18. All health conditions and clinical populations were included.

Data extraction
Descriptive data reported were collated on a data extraction sheet. The measures were evaluated in terms of eight psychometric quality criteria.

Results
Fifty eight studies were included, reporting 61 different measures including 29 questionnaires, 29 logs, two visual analogue scales (VAS) and one tally counter. Only two measures scored positively for one psychometric property (content validity). The majority of measures had no reported validity or reliability testing.

Conclusions
The results expose a gap in the literature for well-developed measures that capture self-reported adherence to prescribed but unsupervised home-based rehabilitation exercises.

Strengths and limitations of this study

- This study highlights the paucity of reported, validated and reliable self-report measures for unsupervised, exercise-based rehabilitation adherence.
- Despite the number and breadth of measures reported, this study reveals only two measures conclusively possessed any psychometric property.

- The study also establishes that the vast majority of measures highlighted in this review had not reportedly undergone any psychometric testing of reliability and validity. However this does not necessarily mean testing was not conducted.

- The lack of reporting regarding tests conducted on a measure does not assume that all measures have poor psychometric properties.

Introduction

Exercise based rehabilitation improves fitness and functional ability for people with long term conditions. [1] These outcomes are hugely important because they make a substantial difference to people's lives and to the economy. However prescribed exercise programmes often comprise a part of home based rehabilitation or self-management for long term conditions and are typically unsupervised by health professionals. Therefore it is unclear if any exercise occurs, if people have engaged in enough exercise to obtain the therapeutic benefit, or if they are sustaining their exercise levels for long enough to self-manage their condition.[2] Finding a way to know what patients are doing and how much they are doing is consequently important and one method that has been used is self-report. We therefore set out to identify what self-report measures have been used for assessing adherence to home based unsupervised exercises, as this focused review has not been conducted before.

We do know that self-report measures can over-estimate as well as under-estimate how much people actually do.[3] Individuals' attitudes and beliefs, coupled with the beliefs of people they interact with, influence intention to exercise,[4] as well as actual levels of exercise adherence. Replies to questions asked about adherence may reflect what the person feels is the desired response rather than a true appraisal of their behaviour, giving a falsely positive estimate of adherence.[5 6] This may be one reason why unsupervised home based exercise programmes are deemed ineffective, when in reality 'an insufficient regimen effect' has occurred.[7]

For the purposes of this review we define adherence as; the degree behaviour corresponds with an agreed upon recommendation. It is a complex and multidimensional construct that can be affected by a number of factors related to the condition, the person (such as forgetfulness, self-efficacy, attitudes and socioeconomic status) and the relationship between the person and healthcare professional.[8]

While there are self-report questionnaires that have been developed and validated for medication based adherence,[9-11] there appears to be a paucity of psychometrically sound self-report measures for recording adherence in the specific context of prescribed but unsupervised home-based rehabilitation exercises for people with long term physical conditions. Thus the aims of this systematic review were to: identify self-report measures of adherence that have been used in this context and to critically evaluate the psychometric properties of these measures.

Methods

Selection Criteria

The inclusion criteria were kept broad to ensure all studies pertaining to measuring exercise adherence were identified. However articles had to:

- Include participants aged 18 and over;
- Use a self-report measure of exercise adherence;
- Indicate that the exercise was in relation to an unsupervised home-based exercise programme that was prescribed as part of a rehabilitation programme for someone with a long term physical condition.
- Be available in English.

There were no restrictions on included health conditions or adult sub-populations or study design. Modified versions of measures were included as were papers reporting separate psychometric evaluation of a measure already identified. Where a study used a measure that had previously been reported, only the original citation was included. No limit was made on the type of measure. Studies that used session attendance as a measure of adherence or clinician-reported adherence were excluded as were papers published only as abstracts.

Information sources

Papers were identified from: Medline (1946 onwards); Embase (1980 onwards) and PsycINFO (1806 onwards) in the Ovid platform; and CINAHL (1981 onwards) in the NHS (UK) platform. These searches were originally performed on the 19th January 2012 and updated on June 27th 2013. The Cochrane database was searched on the 7th of February 2013 and updated on the 9th September 2013. Studies were limited to those that were published in English involving humans, over the age of 18. Hand searching of included studies was also undertaken.

Search Strategy

The search strategy included combinations of keywords and MESH terms which were exploded. Truncations of words were used and search terms were prefixed with 'ti, ab' to ensure the results would contain these words in the abstract. The strategy was modified for CINAHL and the Cochrane database due to different search platforms and MESH terms. Appendix 1 illustrates the detailed search strategy.

Study selection

Titles and abstracts were independently screened for eligibility by two reviewers (JB, VG). Eligible papers were gathered in full text and independently screened by the same reviewers. A third reviewer (SD) facilitated decision making when there were disagreements.

Data extraction

A data extraction sheet designed devised by TH for assessing musculoskeletal rehabilitation measures was modified for this study. Data were extracted regarding: the name of the measure, how the measure was devised, a description of the measure, how the measure was scored, the purpose of the study and the number of participants and the population in which the measure was being used. If the information was not evidenced in the papers 'N/R'

was used to illustrate the information was not reported. The quality of the measures was assessed using the Quality Criteria developed by Terwee et al.[12] Each psychometric property was rated either positive, intermediate, negative or zero (Table 1). Data were extracted by one reviewer (JB) and checked by a second (VG).

Results

The search identified 2264 citations (Figure 1). Fifty eight papers were included, reporting 58 studies and 61 measures of adherence, of which there were 29 questionnaires, 29 logs/dairies, two visual analogue scales (VAS) and one tally counter. Data from 7,424 participants were included. Where reported, there were a total of 2093 males and 2911 females with a mean age of 55.7 years (Standard deviation = 12.4 years). The study populations included those with cancer,[13 14] musculoskeletal,[15-37] cardiovascular,[38-46] respiratory,[47-49] neurological,[50] genitourinary,[51-55] and, endocrine conditions,[56] in addition to war veterans,[57] older people,[58-61] those undergoing surgery,[62-65] those receiving voice therapy,[66] and, sedentary people.[67-70] Appendix 2 provides a detailed description of each included study.

Table 1 provides an overview of each psychometric property and the quality criteria assessment for the included measures. Only two measures achieved a positive rating from the range of psychometric properties, and these were both for content validity.[39 60] The Adherence to Exercise Scale for Older People (AESOP),[60] was developed using two existing scales, the Self-Efficacy for Exercise and the Outcome Expectations for Exercise scales,[71-73] as a basis for developing items that were subsequently evaluated with five older people, modified and re-evaluated with a further five older people. The Heart Failure Compliance Questionnaire,[39] used qualitative interviews with three patients with heart failure to develop questionnaire items that were tested with six specialist nurses, a sociologist and ten people with heart failure.

Table 1: Psychometric properties and quality assessment [15] of the measures reported by the included studies.

Quality Rating	Content Validity	Internal Consistency	Criterion Validity	Construct Validity	Agreement	Reliability	Responsiveness	Floor and Ceiling Effects	Interpretability
Positive[a]	2	0	0	0	0	0	0	0	0
Intermediate[b]	6	5	3	18	0	3	0	1	17
Negative[c]	9	0	0	3	0	0	0	1	*
Zero[d]	44	56	58	40	61	58	61	59	44

* No negative option for this construct

Key

[a]A Positive rating for the adherence measure was obtained when tests for the property in question addressed all the criteria to a satisfactory extent

[b]An Intermediate rating for the adherence measure was obtained when some aspects of the criteria for a positive rating were completed, but not all, or there was doubt about the method or design used to test the psychometric property

[c]A Negative rating for the adherence measure was obtained when the property being assessed proved to be non-existent or fell below specified thresholds despite the method and design used to test psychometric property being sufficient

[d]A zero rating for the adherence measure was obtained when there was no information in the paper or no evidence that this psychometric property had been considered.

Most measures had no evidence that they had undergone any sort of psychometric evaluation although a small number of researchers had attempted to evaluate some measurement properties but used dubious methods or the property being assessed fell below suitable quality thresholds as determined by Terwee et al.[12] In addition, some authors referenced that their measure had established psychometric properties but then modified the scale or used it with a completely different population without re-examining the properties in the revised scale. No studies assessed agreement or responsiveness. Appendix 3 provides a detailed account of each measure in terms of psychometric properties and our quality rating.

Discussion

Principle findings

This is the first systematic review to identify and evaluate measures of self-reported adherence to prescribed, unsupervised home-based rehabilitation exercises for a range of health conditions and populations. We found 58 studies reporting on 61 measures and many of the measures shared similarities but almost all lacked any psychometric validation. This is an absurd and messy situation for appraising the benefits of unsupervised home based exercise rehabilitation.

A few measures had undergone some assessment of measurement properties but these were not considered to meet the quality criteria set by Terwee et al.[12] For example, one study,[19] reported a Pearson correlation coefficient to determine reliability but this is deemed unacceptable due to systematic differences not being accounted for.[12] Two measures,[39 60] were found to have content validity. This is a relatively straight forward property to establish so it is somewhat surprising that more measures did not rate positively for this. Terwee et al.[12] states a measure should only be used if content validity is satisfactory. If content validity is not considered in the measures' construction, it will not be known if the questions are relevant and comprehensive for the target population. Content validity also impacts on floor and ceiling effects and despite the AESOP questionnaire having content validity it was found to have a very strong ceiling effect.

In addition some authors appeared to assume that a measure can be modified and any psychometric properties from the original measure would still stand; however changing a measure may completely undermine any prior assumptions about its validity. This disparity was found when evaluating the internal consistency of one measure,[22 23] which was then modified in another study by adding two questions.[16] This resulted in Cronbach's alphas of 0.93 (original measure) and only 0.63 in the modified measure.

Strengths and limitations

This review had clear inclusion and exclusion criteria and used a robust quality criteria tool to assess the reporting of psychometric properties of the measures. Although the quality criteria tool was designed for health status questionnaires and not specifically for adherence measures we believe it was the best tool available.

A limitation was that only papers available in English were included as there were no resources for a translation. This potential publication bias may impact on the generalisability of our review to non-English speaking countries. Another important aspect to note is that just

because psychometric testing was not reported or was ambiguous this does not mean that it was not conducted or is not of a high quality. We could have overcome some aspects of this by contacting authors for any unpublished supporting data regarding their measure, if it was available. Although this may have aided our ability to judge the quality of the measure's properties, it would not guarantee that the properties were of a high standard.

Comparison with existing literature

Self-reported medication adherence is perhaps the most advanced in the field with questionnaires having been developed and validated although there remains no gold standard measure.[9] A recent review of adherence measures for anti-hypertensive medication suggested 39% of measures indicated some level of reliability and validity, but 33% had undergone no psychometric testing. [74]

Alternative methods of assessing adherence to exercise-based rehabilitation do exist and include attendance at appointments,[75] although this does not necessarily mean the individual is completing the activities they are meant to be doing. Alternatively adherence could be assessed by others; for example the Sports Injury Rehabilitation Adherence Scale (SIRAS)[76] comprises a therapist or trainer-rated observation of whether a patient has completed their exercises as instructed. Due to the supervisory element of SIRAS, the individual may no longer feel they have a choice to adhere; the constant supervision requires their compliance not their adherence. In addition objective measurement methods can be used, such as accelerometers to record physical activity.[77] However these also have limitations for assessing adherence, especially longer term or with large clinical groups, as the devices are expensive and require the participant to adhere to wearing them. In addition the devices act as 'supervisors' which may result in a false view of adherence as the individual may no longer feel they have the autonomy to choose whether or not to adhere.[11] Furthermore these devices do not easily capture the movements of therapeutic exercise. The rapid development of smart phone technology and apps may provide a future solution to this issue albeit still at some cost. At present it is clear that there is no cheap and easily available gold standard measurement of unsupervised exercise-based rehabilitation adherence and so, even with its inherent problems, self-report remains an important option.

Implications for practice and future research

There are a large number of measures that presume to record adherence to prescribed unsupervised home-based rehabilitation exercises but there is a shortage of measures that have been robustly validated. Whilst clinicians generally believe they have some idea as to how adherent their patients are, it is unlikely that their clinical judgement is completely accurate. Coupled with the lack of well-developed measures it becomes very difficult for clinicians to determine if an exercise regime being prescribed is ineffective, and the prescription needs adjusting, or if the individual is non-adherent and requires further support to facilitate uptake and maintenance of their exercise programme.

We have focused on the problems of self-reported exercise adherence and our findings support the urgent need to develop valid and reliable measures. These same challenges

also apply to the self-assessment of outcome and whether Patient Reported Outcome Measures (PROMS) are also sufficiently robust and well validated. Our work also raises questions about how much we should depend upon self-report in health research, whether it works well enough for anything (adherence or outcome) with potentially the best strategy being to utilise a combination of measures across the spectrum of objective, clinician assessed through to patient self-report.

Competing interests

All authors have completed the ICMJE uniform disclosure form atwww.icmje.org/coi_disclosure.pdf and declare: JB, VG and SD had financial support from the National Institute for Health Research (NIHR) for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributorship statement

The idea for the article was devised by SD in conjunction with VG and RJS with JB being the guarantor of this study. The search Strategy was devised by JB with input from SD, VG, RJS and TH with JB then running the literature searches. Screening by title, abstracts and full text applying the inclusion and exclusion criteria was conducted by JB and VG with SD available in the case of disagreement. JB and VG also conducted the data extraction using an adaptation of a form supplied by TH. The compilation of the data was conducted by JB. JB, VG and SD drafted the manuscripts with substantial input from RJS and TH which was then critically revised and refined by all authors

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Funding

This research was funded by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care (CLAHRC) for the South West Peninsula. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health in England.

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3-4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	3-4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	N/A
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	4-5
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Appendix 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	N/A
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	5-7 and Appendix 3
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	7
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	7-8
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	8-9
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	9

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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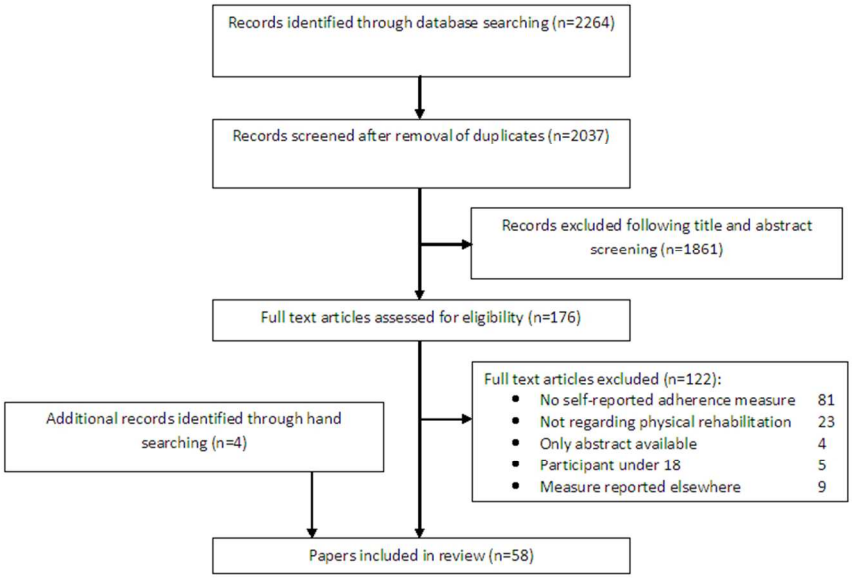

Figure 1. Flow diagram outlining the process of selection of papers for the systematic review

Appendix 1.

Search strategy with limiters for Ovid SP (Medline (R))

1. exp Patient Compliance/
2. patient compliance.ti,ab.
3. ''medic* adhere*''.ti,ab.
4. exp Medication Adherence/
5. 1 or 2
6. 3 or 4
7. (1 or 2) not (3 or 4)
8. exp exercise therapy/ or exp rehabilitation/ or self care/ or exp self administration/
9. exercise therapy.ti,ab.
10. exercise.ti,ab.
11. rehabilitat*.ti,ab.
12. ''self care''.ti,ab.
13. ''self administration''.ti,ab.
14. exp exercise/ or exp muscle stretching exercises/ or exp resistance training/
15. exp Exercise Tolerance/
16. ''physical activity''.ti,ab.
17. "attitude of health personnel"/ or exp attitude to health/
18. value*.ti,ab.
19. attitude*.ti,ab.
20. belief*.ti,ab.
21. (functional adj3 (therapy or restor*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
22. functional therap*.ti,ab.
23. exp Questionnaires/cl, mt, st, td [Classification, Methods, Standards, Trends]
24. exp Self Report/st, ut [Standards, Utilization]
25. questionnaire*.ti,ab.
26. ''self report''.ti,ab.
27. ''patient report''.ti,ab.
28. exp exercise/ or exp physical fitness/
29. 17 or 18 or 19 or 20
30. 23 or 24 or 25 or 26 or 27
31. 7 or 29
32. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 21 or 22 or 28
33. 30 and 31 and 32

(**Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R)** 1946 to Present)

limit 28 to (english language and humans and ("all adult (19 plus years)" or "adolescent (13 to 18 years)"))

Appendix 2. (Table 2a, 2b, 2c and 2d) All measures divided by type, stating the lead author, condition of the participants and pertinent points regarding the measure

2a. Questionnaire based measures of adherence

Author and Condition	[a]Questionnaire name, [b]how devised, [c]description of measure, [d]how scored, , [e] purpose of study [f] number of participants and population, NR= not reported
Barnowski 1998 [62] Surgery: Carpel tunnel	[a] NR [b] NR [c] questionnaire conducted as an interview. Questions asked pertaining to home exercise performance, frequency, and obstacles concerning the exercise programme. Participants then rated their weekly adherence from week 1-6 on a scale ranging from 3=compliant to 0= non-compliant [d] Score was totalled which could range from 0-18 over the 6 weeks [e] To examine the consequence of sex, age, job and going back to work on the recovery of grip strength after surgery for carpel tunnel and the relationship concerning compliance with exercises and the recovery of grip strength [f] 11 Individuals undergoing carpel tunnel surgery
Bassett 2011 [16] Musculoskeletal conditions: Ankle sprain	[a] NR but referred to as a self-report scale [b] NR [c] Scale listed the 5 methods of treatment; exercise, icing, not participating in activities that could be damaging to recovery, strapping of ankle, resting and elevating ankle [d] Participants rated adherence 1-5 for each applicable method of treatment [e] To assess the effect of an education intervention based around Protection Motivation Theory for patients with ankle sprains and the association between the patients intentions, physiotherapy beliefs, adherence, and the ankle injury and function [f] 69 individuals with ankle sprains
Bennell 2012 [17] Musculoskeletal conditions: Osteoarthritis	[a] NR but referred to as a self- report questionnaire [b] NR [c] Two questions asked at 3,6,9,12,15 and 18 months; one pertaining to the frequency the exercises was performed during the past two weeks, for the second question the participant is asked to rate their adherence to the home based exercises between 1= 'not at all'-11= 'completely as instructed' . [d] NR [e] To assess the effectiveness -both clinical and cost- of coaching over the telephone in addition to physiotherapy for the target population [f] 0 participants as a prospective study but would hope to recruit 168 participants with knee osteoarthritis
Borello-France 2010 [52]	[a] NR [b] NR but based on questionnaire by Sluijs et al '93 [c] Completed at clinical centre at visit number 2, 3 and 4 out of 4 visits and

Genitourinary conditions: Urge incontinence	throughout year at 2,4, 6 and 12 months with minor alterations to make it relevant during the follow-up period. Consisted of 9 questions; 2 questions about frequency of carrying out exercises and completing all repetitions with choice of 4 answers. 7 questions regarding exercise barriers with the choices of 'yes', 'no' and 'uncertain' [d] averages were determined based on number of exercises performed per day and number of days per week the exercises were conducted divided by 7. An average of all the means was taken over the intervention and follow-up. [e] To depict adherence to pelvic floor exercises, look at the barriers present preventing exercises being conducted, and detect factors associated with adherence to the exercises [f] 154 females with urinary incontinence
Chen 2009 [54] Genitourinary conditions: Urinary incontinence	[a] NR [b] NR but devised by author [c] Questionnaire consisted of 3 items. Items 1 and 2 regard time spent and number of exercises completed on a 5 and 6 item scale respectively. Item 3 was a Visual Analogue Scale (VAS) ranging from 0-10 where participants rate compliance. Completed face to face if possible but could also be posted. [d] The three items were combined with a possible range scoring between 2-21 [e] To construct a model depicting direct and indirect sources of adherence and then to test the model [f] 106 female participants with urinary incontinance
Courneya 2004 [13] Cancer: Colorectal	[a] Leisure Score Index (LSI) modified from the Godin Leisure-Time Exercise Questionnaire [b] Added a question to the pre-existing questions regarding the average length of time spent exercising [c] 3 open-ended questions regarding the participants average frequency and intensity of exercise. The modification referred to including a question regarding average time spent exercising. Participants complete the measure weekly over the telephone talking to a researcher [d] The average frequency of exercise was multiplied by the average duration of exercise at 3 intensity levels (mild, moderate and strenuous). The minutes spent in moderate and strenuous exercise will then be summed. The moderate and strenuous level minutes were then combined [e] To explore predictors of adherence to exercise and exercise contamination in the target population [f] 102 participants with colorectal cancer
Dobkin 2008 [19] Musculoskeletal conditions: Fibromyalgia	[a] GAS [b] Used previously in hypertensive medication adherence but not in exercise rehabilitation adherence. [c] a 6 point 1-6 scale regarding general inclination to adhere. Self-reported by participants Carried out at 1, 2 and 3 months. Regarding adherence in the past month [d] The average of the 5 items was calculated and then converted into a number ranging 0-100

	[e] To describe adherence, determine predictors of adherence and apprise the association between adherence to treatment and outcome in individuals with fibromyalgia [f] 63 participants with Fibromyalgia
	[a]SAS [b] Devised by authors [c] 17 items on 4 point 0-3 scale regarding adherence in the past week. Self-reported by participants and carried out at months 1,2 and 3 [d] The average of the 17 items was calculated and then converted into a number ranging 0-100 [e] To describe adherence, determine predictors of adherence and apprise the association between adherence to treatment and outcome in individuals with fibromyalgia [f] 63 participants with Fibromyalgia
Evangelista 2001 [39] Cardiovascular Conditions: Heart failure	[a] The Heart Failure Compliance Questionnaire [b] based on an existing measure for myocardial infarction. Three heart failure patients were interviewed to create items that were relevant to the target population and decide what other themes the questionnaire should consist of. This was then reviewed by six specialist nurses, one sociologist and ten participants involved in the study regarding comprehensiveness and length of the questionnaire [c] 6 subsections regarding health behaviours were on the questionnaire. Participants responded on a 5 point scale how important they rated each health behaviour. They then had to rate their overall adherence on a 5 point scale. [d] The mean was calculated for each health behaviour and a combined score for all behaviours. Participants were deemed adherent if the combined score was above 75% [e] For health care workers to be able to identify non adherence and contributing factors that could lead to non-adherence [f] 82 participants with heart failure
Forkan 2006 [59] Older people: Impaired balance	[a]NR [b] Devised by authors based on literature and piloted on the target population and physical therapists [c] A 43 item questionnaire containing 1 open ended question and 7 subscales. [d] Subscale scores were summed together after responding on a 4 point scale [e] To ascertain adherence after discharge and the factors limiting adherence in addition to characterising involvement in the exercise [f] 175 participants who were over 65 years of age with impaired balance
Gallo 1997 [55] Genitourinary conditions: Stress urinary incontinence	[a]NR but referred to as a survey [b] Devised by authors for the study. Content validity was attempted using experts but no-one from the target population. Test-retest reliability was also attempted utilising 10 participants over a 1 week timespan. [c] Questionnaire with 4 sections pertaining to: number of times per day the exercises were conducted on average; the duration of time spent performing the exercises; the length of time each exercise held for; the reason for

	conducting exercises. Additional questions pertaining to use of cassette tape if in group utilising this intervention [d] NR [e] To determine if use of a cassette tape improves adherence to pelvic floor exercises in addition to; how many participants perform the exercises regularly, how many perform the exercises as prescribed, length of time spent performing the exercise programme, length of time each exercise held and, what prompts the individuals to conduct the exercises [f] 88 females with urinary incontinance
Hardage 2007 [60] Older people: Activity	[a]AESOP [b] Used items from pre-existing scales which could be modified, deleted or added to. This was then checked for applicability in the target population [c] The questionnaire was conducted as an interview with researcher. There were 3 subscales with a total of 45 items with were responded to on a 5 point scale [d] The scores for each of the subscales were summed separately resulting inn 3 totals [e] To produce a questionnaire to predict adherence to home based exercise [f] 50 participants aged 65 years old and over
Howard 2008 [21] Musculoskeletal conditions: Osteopathy patients	[a]No name [b] Devised by authors based on literature and attempts at face and content validity were made piloting the measure on 5 experts and 5 individuals from the target population [c] The self-report questionnaire comprises of 3 subscales; attitudes and experiences in regards to exercise and health; whether the participant had an exercise programme; whether the exercise programme had been carried out as specified. These were all scored on a 5 point scale. The final question required a yes or no answer regarding their completion of prescribed exercises [d] Each subscale was summed based on the scores from the 5 point scales [e] To devise a pilot measure to determine characteristics in the participants that may influence adherence to the prescribed exercise programmes and to investigate if adherent participants differed from non-adherent participants [f] 200 participants who were osteopathy patients
Jurkiewicz 2011 [41] Cardiovascular conditions: Stroke	[a]NR [b] Modified from a questionnaire by Marzolini and literature. State no validity or reliability testing was conducted but face validity was attempted by asking patients, physicians and cardiac rehabilitation staff pertinent questions regarding its relevance and range of questions [c] Self-report questionnaire with 16 items. Multiple choice for most questions but could write different response [d] NR [e] To determine factors affecting adherence to prescribed exercise programme conducted at home for the target population. [f] 14 stroke survivors

Khalil 2012 [50] Neurological conditions: Huntington's Disease	[a] NR [b] NR [c] Weekly telephone call to conduct verbal questionnaire. Asked if participants had conducted their exercises for the previous week; the frequency with which they had conducted them; which exercises they had carried out; if any difficulties had been encountered whilst conducting the exercise; and if the participant had any concerns [d] NR [e] To examine how individuals with Huntingdon's Disease and their carers perceived and used a specially developed exercise DVD [f] 15 participants with Huntington disease
Kim 2006 [56] Endocrine conditions: Type 2 diabetes	[a] NR [b] NR but based on 7- day physical activity questionnaire [c] recall questionnaire of all physical activity conducted during the last 7 days. Cues such as time of the day were used to aid recall. Participants were asked the frequency, duration and intensity with which they carried out each activity or exercise. [d] MET's were calculated for activates conducted and an overall physical activity energy score was obtained which depended on the amount of time and intensity of the exercises conducted [e] To determine the success of a web based and printed material Trans-Theoretical Model intervention programme for people with type 2 diabetes [f] 73 participants with type 2 diabetes
Levy 2008 [22] Musculoskeletal conditions: Tendonitis over use injury	[a]No name [b] NR but based on Bassett (2003) [c] The measure asked participants about adherence to exercises, cryotherapy and avoiding participating in activities that could aggravate injury on a 5 point scale 1= not at all- 5= as advised [d] scores for each question were summed together to arrive at an adherence total [e] To examine the associations between adherence to rehabilitation, age and perceived autonomy support [f] 70 participants with tendonitis overuse injury
Levy 2008 [23] Musculoskeletal conditions: Tendonitis over use injury	[a]No name [b] NR but based on Bassett (2003) [c] The measure asked participants about adherence to exercises, cryotherapy and avoiding participating in activities that could aggravate injury on a 5 point scale 1= not at all- 5= as advised [d] scores for each question were summed together to arrive at an adherence total [e] To attempt to predict adherence to rehabilitation by examining an adapted integrated psycho-social model [f] 70 participants with tendonitis overuse injury

Lysack 2005 [64] Surgery: Hip or knee replacements	[a]NR [b] NR but the questionnaire was developed for the study [c] Conducted as Interview with researcher. Questions pertained to how regularly exercises were performed, difficulties with doing the exercises, any problems remembering to do the exercises, satisfaction with rehabilitation whilst an inpatient and satisfaction with therapeutic exercises [d] NR [e] To establish if adherence and satisfaction were improved if a personalised video tape with the exercises was used when completing the exercises at home as opposed to written instructions and verbal instruction [f] 40 participants with a hip or knee replacement
Mailloux 2006 [24] Musculoskeletal conditions: Chronic low back pain	[a]NR [b] NR [c] Recorded how often the exercises were performed per week out of 4 adherence caregories ranging from never to more than 5 times a week. Questionnaire completed at evaluation of the programme and at the 2 year follow up [d] NR [e] To try and establish if exercise behaviours were improved after rehabilitation and if they were maintained at follow up 2 years post rehabilitation. [f] 126 participants with back pain over 65 years of age
Marzolini 2010 [43] Cardiovascular conditions: Cardiac patients	[a] NR [b] devised by a physician, researcher and a cardiac rehabilitation clinician, in conjunction with a market research professional [c] Questionnaire contained 52 items [d] NR [e] To determine factors that may influence long term adherence to home based exercise programmes retrospectively [f] 358 participants who were cardiac patients
McCarthy 2004 [26] Musculoskeletal conditions: Osteoarthritis	[a] NR [b] NR [c] Questionnaire was completed at a 6 and 12 month assessment after the intervention. It comprised of four questions; how often are the exercises completed during a week over the past month; the length of time spent conducting the exercises; If they have stopped completing the exercises, the length of time since the individual last did the exercises, and, if the individuals felt there had been any change in physical activity levels during the last six months. There were multi-choice options. [d] NR [e] To determine the effect and cost of delivering an exercise programme to be conducted purely at home opposed to an exercise programme conducted at home in conjunction with a course of exercise classes [f] 214 participants with osteoarthritis
Medina-Mirapeix 2009 [27]	[a]NR [b] NR but adapted from Sluijs et al (1993) [c] Asked to record frequency and duration for conducting the exercise

Musculoskeletal conditions: Neck and low back pain	programme on a 5 point scale (never, seldom, often, almost always, always) for the past week 1 month after finishing physiotherapy [d] Individuals reporting the always, and almost always options on the were deemed as adherent [e] To examine the levels of adherence and if they differ when prescribed home based exercise in relation to the frequency and duration and if the frequency and duration could be predicted by certain factors. [f] 184 participants with neck and low back pain
Milne 2005 [29] Musculoskeletal conditions: Injured athletes	[a] NR [b] NR [c] Three areas in relation to rehabilitation were enquired about; the frequency, duration and quality of the exercises in five questions. The sections regarding frequency and duration each asked 2 questions regarding the physiotherapist's recommendation and what the participant did. 1 question regarded the quality, asking as a percentage how often the participant thought they did the exercises correctly. [d] Percentages were calculated for the two questions regarding frequency and the two regarding duration. Quality was already presented in percentage terms [e] To assess the validity of the Athletic Injury Self- Efficacy Questionnaire (AISEQ) and the predictive associations between the questionnaire measuring self-efficacy, adherence to rehabilitation and imagery use [f] 270 injured athletes participated
Rackwitz 2007 [30] Musculoskeletal conditions: Chronic low back pain	[a] NR [b] NR but devised by the author [c] Questions pertaining to number of days and length of time the rehabilitation programme was conducted during the past week. Questionnaire completed during the 8 week intervention and at a follow up at 3 months [d] NR [e] To assess if the rehabilitation programme was practical, what effects the programme may have and if people were adherent to the programme. [f] 92 participants with low back pain
Radtke 1989 [45] Cardiovascular conditions: Cardiac rehabilitation	[a]Exercise Compliance Questionnaire [b] Devised by author based on literature [c] 8 item measure. 6 questions about frequency, duration, intensity and method of exercise scored on a 5 point scale. 2 questions pertaining to before the heart attack [d] Scores were weighted for questions 1 to 6 which produced a number between 30 to 150. Individuals scoring less than 50 were deemed as low adherers and individuals scoring over 100 deemed high adherence [e] To establish if individuals conducted their home exercises as prescribed and if self-motivation affects their adherence to the prescribed home exercises [f] 28 participants who have suffered a myocardial infarction
Sluijs 1993 [35]	[a] NR [b] NR

Musculoskeletal conditions: Physiotherapy patients	[c] 1 question asking if the participant regularly exercised in the past week. Responses were recorded in 1 of 4 categories ranging from not at all to very regularly. [d] NR [e] To determine if adherence to exercise was associated with characteristics of the individual in or the behaviour of the physical therapist [f] 1681
Terpstra 1992 [37] Musculoskeletal Conditions: Rheumatoid arthritis	[a]No name [b] NR [c] Questionnaire had two sections. One section regarding conducting the exercise programme with 6 questions and the other section about factors that may influence conducting the programme with 11 questions. Face validity was conducted and the authors attempted to establish applicability [d] means and frequencies were calculated combining the two sections of the questionnaire [e] to establish the degree with which individuals adhered and what factors are associated with adherence to their exercise programmes [f] 104 participants with rheumatoid arthritis
White 2007 [49] Respiratory conditions: Cystic fibrosis	[a] NR [b] NR but developed for this study and based on the Manchester Cystic Fibrosis Compliance Questionnaire. It was also piloted by 2 individuals from the target population who provided feedback which was utilised [c] Consisted of three sections; background; adherence to airway clearance; and, adherence to exercise programmes. It was conducted as an interview with a physiotherapist [d] NR [e] To establish the level of adherence in the target population and determine factors that increased or decreased levels of adherence [f] 57 participants with cystic fibrosis

2b. Log based measures of adherence

Author and Condition	[a] Log/ Diary [b]how devised, [c]description of measure, [d]how scored, [e] purpose of study, [f] number of participants and population, NR= not reported
Alewijnse 2003 [51] Genitourinary conditions: Urinary incontinence	[a]7- day diary [b] NR [c] Participants were asked to report the number of days during the week that the participants had carried out the exercises as per the physiotherapist's instructions. They were asked to report this on a 5 point scale with the first three response options in regards to non-adherence, the fourth option in regards to moderate adherence and the final option in response to ideal levels of adherence [d] NR [e] To identify long term predictors of adherence in the target population [f] 192 participants with urinary incontinence

Alexandre 2002 [15] Musculoskeletal Conditions: Low back pain	[a] NR but referred to as a diary [b] NR but physical therapists had input into the adherence rating categories [c] The diary recorded exercise frequency each week. Adherence was rated between 0-2 A rating of 2 was someone who was highly adherent and the individual completed 80% of the prescribed exercise, a rating of 1 was a low adherer and the individual had completed less than 80% of the prescribed programme and a rating of 0 was the rating for an individual who was not adherent [d] The diary score was summed with a score for attendance at a clinic session and score for using an educational videotape to obtain an overall adherence score [e] To examine if a number of factors such as demographics, quality of life, barriers in regards to completing the treatment and depression among others were able to predict the adherence of the individual to the programme. [f] 120 participants with back pain
Borello-France 2008 [53] Genitourinary conditions: Stress urinary incontinence	[a] NR but referred to as Exercise Diary [b] NR [c] The diary was used to record exercise sessions that were carried out each week [d] scored as a percentage which was obtained by dividing the number of exercise sessions conducted as reported in the diary by the number of exercises sessions that were prescribed [e] To assess quality of life and continence after a six month intervention and to determine the effectiveness of maintaining the exercise programme over the follow up [f] 28 female participants with urinary incontinence
Brovold 2012 [58] Older People: Activity	[a] NR but referred to as Exercise Log [b] NR [c] Log recorded various activities frequency and duration providing the duration was more than 10 minutes. [d] The mean of reported activities conducted each week was calculated [e] To assess the effects of an exercise and counselling intervention on HRQL and physical ability [f] 108 participants in adults over 60
Chen 1999 [18] Musculoskeletal conditions: Physiotherapy patients	[a]NR but referred to as self-report and follows a log format [b] NR but designed for study [c] The log recorded each exercise conducted, the number of times the exercise was repeated in the session and the number of sessions that were recommended by therapists to do each day. Also recorded were the frequency and duration of exercise sessions in addition to the number of exercise sessions conducted typically per day during the week [d] Percentages were calculated comparing the number of exercise sessions actually completed to the participants recollection of prescribed exercise sessions and to the actual prescribed amount [e] To examine predictive factors for increased adherence and

	satisfaction to exercise programmes conducted at home [f] 62 participants with upper extremity impairment
Cockram 2006 [47] Respiratory conditions: Pulmonary rehabilitation	[a] NR [b] NR [c] Standardised questions used (not reported) to record the type and frequency of exercises carried out at home in addition to any attendance at exercise classes and other physical activity. [d] NR [e] To outline referral and uptake patterns to rehabilitation and the benefits of the rehabilitation in individuals participating in maintenance programmes in a community setting [f] 21 participants undergoing pulmonary rehabilitation
Donesky-Cuenco 2007 [48] Respiratory conditions: COPD	[a] NR but referred to as a daily log [b] NR [c] Recorded the length of time, number of walks along and level of dyspnea after each walk per day [d] dependent on the number of walks conducted compared with the number prescribed, participants were separated into seven categories of adherence [e] To examine behaviour and adherence in regards to the exercise treatment and to validate the adherence categories [f] 103 participants with Chronic Obstructive Pulmonary Disease
Duncan 2002 [38] Cardiovascular conditions: Heart failure	[a]NR but referred to as an exercise diary [b] The targets for the participants to meet in terms of exercise frequency etc were written in the diaries for the participants to conduct unsupervised [c] the diaries recorded the duration and frequency of the prescribed exercises in addition to the type of exercise carried out and an RPE [d] Adherence was measured by a percentage, dividing the number of exercise sessions carried out by the number of sessions prescribed. [e] To evaluate the efficacy of the adherence intervention [f] 13 participants with heart failure
Ettinger 1997 [20] Musculoskeletal conditions: Osteoarthritis	[a]NR but referred to as an exercise log [b] NR [c] The log recorded the frequency and duration of the exercises. [d] Adherence was calculated as a percentage based on the number of exercise sessions completed compared to the number of exercise sessions prescribed [e] To evaluate the effect exercise programmes have on self-reported disability for the target population [f] 439 participants aged 60 years and above with knee osteoarthritis
Fukuoka 2011 [67] Sedentary lifestyles: Activity program for Sedentary Women	[a] Daily Mobile phone diary [b] NR [c] The log was completed every evening between 7pm-12am. It recorded the frequency, intensity and duration of physical activity carried out and the number of steps taken that day and if they wore the pedometer as they were supposed to for the study

	[d] adherence was calculated by dividing the number of diary entries over a month by 21 days resulting in a percentage [e] To assess adherence to pedometer and diary use and the congruence between the steps taken as reported in the diary and the steps recorded by the pedometer [f] 41 sedentary female participants
Gary 2011 [40] Cardiovascular conditions: Heart failure	[a] NR but referred to as a Step/ chord calendar [b] NR [c] Recorded adherence to resistance exercises. The number of exercises carried out, the number of repetitions and Thera-chord colour were all recorded each week which was then collected by nurse or exercise specialist and inputted onto the log sheet. [d] 2 resistance exercise sessions had to be recorded on the calendar in addition to another exercise session recorded differently to be deemed adherent [e] To examine the outcome of the exercise programme on the participants physical function [f] 24 participants with heart failure
Hardage et al, 2007 [60] Older people: Activity	[a] NR but referred to as a daily home exercise log [b] NR [c] Days where participants exercised, an 'E' was marked on the calendar log. If participant had a fall they marked an 'F' to detract from the variable of adherence [d] Individuals were rated adherent if exercise was conducted three times a week [e] To produce a questionnaire to predict adherence to home based exercise programmes [f] 50 participants aged 65 years old and over
Khalil 2012 [50] Neurological conditions: Huntington's Disease	[a] NR but referred to as an exercise diary [b] NR [c] The log recorded which exercises were carried out each week between one and three times. [d] NR [e] To examine how individuals with Huntingdon's Disease and their carers perceived and used a specially developed exercise DVD [f] 15 participants with Huntington disease
King 1991 [68] Sedentary lifestyles: Activity program	[a] NR but described as an exercise log [b] NR [c] The log recorded the type of exercise carried out, the frequency and duration of exercise, heart rate while exercising and an RPE was recorded for each exercise session [d] an adherence score was calculated each month by expressing the number of sessions completed as a percentage of the number of sessions that were set for the 4 week period [e] to examine how effective group based exercise training was in comparison to home based training at high and low intensities [f] 357 participants leading a sedentary lifestyle between the ages of 50

	and 65
King 2012 [42] Cardiovascular conditions: Stroke	[a] NR but referred to as diaries [b] NR but reference to Bassett 2003 commenting self-report measures are a good technique to assess adherence [c] Recorded frequency and duration of sessions. Participants were aware sessions must be less than 90 minutes. [d] NR [e] To assess the potential of using computer games in the target population for therapy [f] 3 participant who were recovering from a stroke
Lyngcoln 2005 [63] Surgery: Distal radius fracture	[a] NR but referred to as a home exercise diary [b] NR [c] Recorded the number of exercise sessions the participant carried out and the number of exercises conducted per session [d] A percentage was calculated based on the number of exercise sessions completed compared to the number of exercise sessions prescribed [e] To study the association between adherence to the prescribed exercise and the outcome [f] 15 participants with distal radius fracture
Mannion 2009 [25] Musculoskeletal conditions: Chronic low back pain	[a] NR but referred to as a daily exercise diary [b] NR [c] The log recorded the frequency with which the exercises were completed [d] A percentage was calculated based on the number of exercise sessions completed compared to the number of exercise sessions prescribed [e] To observe how adherence influences self reported disability and pain scores and to establish factors that may influence adherence [f] 32 participants with chronic low back pain
Mori 2006 [57] War veterans: Gulf war veterans illness	[a] NR but referred to as a daily log [b] NR [c] The frequency, intensity and duration of exercise were recorded. In addition the participants had to report as to how they had measured the exercise intensity from the choice of; heart rate, METs or RPEs [d] NR [e] To examine predictors of exercise adherence for the condition of the target population [f] 531 participants with Gulf War Veterans illness
Oka 2000 [44] Cardiovascular conditions: Heart failure	[a] NR but referred to as an activity log [b] NR [c] The logs were filled in daily and recorded RPE, heart rate, exercises completed and the duration of the exercises, and any symptoms that occurred [d] A percentage was calculated based on the number of exercise sessions completed compared to the number of exercise sessions prescribed

	[e] To assess the outcome of a home based exercise programme on levels of fitness, quality of life and symptoms in the population of interest [f] 40 participants with heart failure
Pickett 2002 [14] Cancer: Breast	[a]NR but referred to as a daily diary [b] Devised by authors and used in previous studies but not measuring adherence. Content validity was attempted by a panel of oncology nurses and nurse researchers and exercise physiologists. No target population input. [c] The diary recorded fatigue, duration of walking, pulse rate before and after walking in addition to any side effects or symptoms of disease experienced [d] NR [e] To observe adherence patterns to the exercise programme and examine if the disease of the target population or side effects from the treatment affect the levels of exercise completed. In addition to propose other methods that could improve future studies examining moderate intensity exercise in comparable groups to the target population [f] 52 participants breast cancer recently diagnosed
Saez 2004 [32] Musculoskeletal conditions: Injured athletes	[a]NR but referred to as a personalised record sheet [b] designed by the authors for the particular individual factoring in the rehabilitation programme suggested by the doctor [c] Content of sheet regards rehabilitation recommended for individual participant by doctor and is completed each week [d] Adherence throughout the study was established by determining a weekly mean to calculate an overall mean for adherence [e] To examine psychological responses and the impact they have on the recovery of the participant [f] 20 participants with injuries sustained via football
Salo 2012 [33] Musculoskeletal conditions: Chronic neck pain	[a] NR but referred to as exercise diaries [b] NR [c] Recorded how often an exercise session took place, which exercises were conducted, the repetitions of the exercises and weights used. [d] A mean and standard deviation of the training frequency was calculated [e] To assess if exercises for the target population can increase HRQL [f] 101 participants with neck pain
Schoo 2005 [34] Musculoskeletal conditions: Osteoarthritis	[a] NR but referred to as a diary and log sheet [b] taken from pre-existing diary recording wet episodes in incontinence patients [c] Recorded how many exercises- as in all, some or none- had been carried out each day [d] A percentage was calculated regarding how much of the exercise programme was performed. [e] To determine factors related to exercise programme adherence [f] 90 participants with osteoarthritis over the age of 60

Spink 2012 [61] Older People: Podiatry/ falls	[a] NR but referred to as a daily exercise diary [b] NR [c] Recorded the frequency with which the exercises were carried out. [d] Adherence was deemed as the participant reporting 50% or more of the prescribed exercise being completed [e] To examine adherence, predictors of adherence and barriers to the intervention in the target population [f] 153 participants aged 65 years and over that are prone to falling
Steinhilber 2012 [36] Musculoskeletal conditions: Osteoarthritis	[a] NR but referred to as exercise logs [b] NR [c] Recorded frequency and duration of exercise in addition to pain and exertion experienced whilst conducting the exercises. [d] Adherence was measured by comparing the number of exercise sessions conducted compared to the number of sessions prescribed [e] To add a home based exercise programme to a pre-existing group based exercise session and to discover if it can be conducted by the target population [f] 36 participants with osteoarthritis of the hip or have had a hip replacement
Tooth 1993 [46] Cardiovascular Conditions: Myocardial Infarction	[a]NR but referred to as a log book [b] NR [c] the logs recorded the duration and frequency of exercises per week [d] Frequency and duration of exercise completed was summed and compared to the amount of exercise prescribed [e] To explore if certain characteristics at baseline could be predict participants adherence to the exercise programme [f] 30 participants that have suffered a myocardial infarction
Wang 2012 [69] Sedentary lifestyles: Weight loss	[a] NR but referred to as diaries [b] NR [c] the logs recorded the frequency of the exercise providing it was more than twice a week and the duration of the exercise providing it was a minimum of 30 minutes [d] NR [e] To discern the effectiveness of self- reported logs for weight loss in the target population [f] 50 chronically ill obese participants
Wilbur 2001 [70] Sedentary lifestyles: activity programme for sedentary healthy women	[a] NR but referred to as exercise logs [b] NR [c] The logs recorded date, if they completed the warm up and cool down properly and in entirety, the duration of time spent walking and estimated number of miles walked. Participants were encouraged to note weather, terrain, route taken, and how the participant felt whilst walking. [d] NR [e] To exhibit the used of an exercise log in conjunction with a heart rate monitor to measure adherence to prescribed exercise in addition to

	recommending a different way to describe adherence to an exercise programme that reflects the process of behaviour change [f] 156 female participants leading sedentary lifestyles
Zagarins 2011 [65] Surgery: Bariatric surgery patients	[a]NR but referred to as a weekly exercise log [b] NR [c] the logs recorded the frequency and duration of the exercise sessions, the type of exercise performed, Borg scale rating during exercise and data pertaining to pedometer use per week [d] means and standard deviations were calculated from the results [e] To assess adherence and evaluate the efficacy of an exercise programme [f] 46 participants who have undergone bariatric surgery

2c. Visual Analogue Scale (VAS) based measures of adherence

Author and Condition	[a] Log/ Diary [b]how devised, [c]description of measure, [d]how scored, [e] purpose of study, [f] number of participants and population, NR= not reported
Michener 2001 [28] Musculoskeletal conditions: Physiotherapy patients	[a] NR but was a VAS [b] NR [c] 14.5cm long line with percentages 0, 25, 50, 75 and 100% marked on the line to anchor it. [d] The mark on the line from the participant measuring their percentage adherence was converted into cm [e] To establish if grip strength recovery was related to work performance and functional results after completing occupational therapy [f] 15 participants with hand trauma
Roddey 2002 [31] Musculoskeletal conditions: Physiotherapy patients	[a] NR but was a VAS [b] NR [c] a 10 cm line with the anchors at each end regarded completing no exercise to completing all exercises for the week. A mark was then made on the line to denote the participants adherence levels [d] Adherence was assessed depending on the number of VAS' returned to the researchers by the participant and the level of adherence they had indicated [e] To evaluate the success of a video tape intervention as opposed to a physical therapist providing instruction on adherence to home based exercises and the outcome of individuals in the target population [f] 108 participants following Rotator Cuff repair surgery

2d. Other based measures of adherence

Author and Condition	[a] Log/ Diary [b]how devised, [c]description of measure, [d]how scored, [e] purpose of study, [f] number of participants and population, NR= not reported
van Leer 2012 [66] Vocal: Voice therapy	b[a] Tally counter [b] NR [c] A small devise that the participant had on their person to record each time the exercises were performed for at least a 2 minute duration. This form of monitoring adherence was conducted for the 1st 2 weeks and data was obtained at 3 time points during these 2 weeks [d] NR [e] To assess if adherence and motivation can be enhanced by interventions put In place (support for practice using mobile videos) [f] 14 participants undergoing voice therapy

Appendix 3. Table displaying the evaluated Psychometric Properties of all measures included in the systematic review

					reproducibility				
Author and year	content validity	internal consistency	criterion validity	construct validity	agreement	reliability	responsiveness	floor and ceiling	interpretability
Alewijnse 2003 [51]	0	0	0	?	0	0	0	0	?
Alexandre 2002 [15]	-	0	0	?	0	0	0	0	0
Barnowski 1998 [62]	0	0	0	?	0	0	0	0	?
Bassett 2011 [16]	0	?	0	?	0	0	0	0	?
Bennell 2012 [17]	0	0	0	0	0	0	0	0	0
Borello-France 2008 [53]	-	0	0	0	0	0	0	0	0
Borello-France 2010 [52]	0	0	0	0	0	0	0	0	0
Brovold 2012 [58]	0	0	0	0	0	0	0	0	0
Chen 1999 [18]	0	0	0	?	0	0	0	0	0
Chen 2009 [54]	?	?	0	0	0	0	0	0	0
Cockram 2006 [47]	0	0	0	0	0	0	0	0	0
Courneya 2004 [13]	0	0	0	?	0	0	0	0	0
Dobkin 2008 [19]									
GAS	0	0	0	?	0	?	0	0	?
SAS	0	0	0	?	0	0	0	0	?
Donesky-Cuenco 2007 [48]	0	0	0	?	0	0	0	0	?

Duncan 2002 [38]	0	0	0	0	0	0	0	0	0
Ettinger 1997 [20]	0	0	0	0	0	0	0	0	0
Evangelista 2001 [39]	+	?	0	?	0	0	0	0	0
Forkan 2006 [59]	?	0	0	0	0	0	0	0	0
Fukuoka 2011 [67]	0	0	0	?	0	0	0	0	0
Gallo 1997 [55]	?	0	0	0	0	?	0	0	0
Gary 2011 [40]	0	0	0	0	0	0	0	0	?
Hardage 2007 [60] AESOP Monthly calendars	 + 0	 0 0	 ? 0	 - 0	 0 0	 ? 0	 0 0	 - 0	 0 0
Howard 2008 [21]	?	0	0	?	0	0	0	0	?
Jurkiewicz 2011 [41]	0	0	0	0	0	0	0	0	?
Khalil 2012 [50] Telephone questionnaire Log	 0 0	 0 0	 0 0	 0 0	 0 0	 0 0	 0 0	 0 0	 0 0
Kim 2006 [56]	0	0	0	0	0	0	0	0	?
King 1991 [68]	0	0	?	?	0	0	0	0	?
King 2012 [42]	0	0	0	0	0	0	0	0	0
Levy 2008 [22]	0	?	0	-	0	0	0	0	?
Levy 2008 [23]	0	?	0	-	0	0	0	0	?

Lyngcoln 2005 [63]	0	0	0	?	0	0	0	0	0
Lysack 2005 [64]	0	0	0	0	0	0	0	?	0
Mailloux 2006 [24]	0	0	0	0	0	0	0	0	?
Mannion 2009 [25]	0	0	0	?	0	0	0	0	0
Marzolini 2010 [43]	-	0	0	0	0	0	0	0	0
McCarthy 2004 [26]	0	0	0	0	0	0	0	0	0
Medina-Mirapeix 2009 [27]	0	0	0	0	0	0	0	0	0
Michener 2001 [28]	-	0	0	0	0	0	0	0	0
Milne 2005 [29]	0	0	0	0	0	0	0	0	0
Mori 2006 [57]	0	0	0	?	0	0	0	0	0
Oka 2000 [44]	0	0	0	0	0	0	0	0	0
Pickett 2002 [14]	-	0	0	0	0	0	0	0	0
Rackwitz 2007 [30]	-	0	0	0	0	0	0	0	0
Radtke 1989 [45]	-	0	0	?	0	0	0	0	0
Roddey 2002 [31]	0	0	0	0	0	0	0	0	?
Saez 2004 [32]	-	0	0	0	0	0	0	0	0
Salo 2012 [33]	0	0	0	0	0	0	0	0	0
Schoo 2005 [34]	-	0	0	0	0	0	0	0	?

Sluijs 1993 [35]	0	0	0	?	0	0	0	0	?
Spink 2012 [61]	0	0	0	0	0	0	0	0	0
Steinhilber 2012 [36]	0	0	0	0	0	0	0	0	0
Terpstra 1992 [37]	?	0	0	0	0	0	0	0	0
Tooth 1993 [46]	0	0	0	0	0	0	0	0	0
van Leer 2012 [66]	0	0	0	0	0	0	0	0	0
Wang 2012 [69]	0	0	0	0	0	0	0	0	0
White 2007 [49]	?	0	0	0	0	0	0	0	0
Wilbur 2001 [70]	0	0	?	0	0	0	0	0	0
Zagarins 2011 [65]	0	0	0	0	0	0	0	0	0

Key

The criteria the construct needed to obtain to get a certain rating varied greatly as each aspect was different. Therefore please see [15] for the criteria needed for each construct for the different ratings.

+= A positive rating where the paper and measure have addressed each of the criteria for a positive rating to a satisfactory extent

?= An intermediate rating where the paper and measure have possibly completed some of the aspects needed for a positive rating, but not all of the required aspects or the method or design used is doubtful

-= A negative where the aspect being measured proved to be non-existent or fall below specified thresholds despite the method and design used were sufficient

0= A 0 was accredited when there was no information in the paper or evident in the measure that this aspect had been considered.

BMJ Open

A systematic review of measures of self-reported adherence to unsupervised home-based rehabilitation exercise programmes, and their psychometric properties

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2014-005044.R1
Article Type:	Research
Date Submitted by the Author:	27-May-2014
Complete List of Authors:	Bollen, Jessica; University of Exeter Medical School, PenCLAHRC Dean, Sarah; University of Exeter Medical School, PenCLAHRC, Siegert, Richard; Auckland University of Technology (AUT), School of Public Health and Psychosocial Studies and School of Rehabilitation and Occupational Studies Howe, Tracey; Glasgow Caledonian University, School of Health and Life Sciences Goodwin, Victoria; University of Exeter Medical School, PenCLAHRC
Primary Subject Heading:	Rehabilitation medicine
Secondary Subject Heading:	Health services research, Sports and exercise medicine
Keywords:	Adherence, Self-report, Exercise, Rehabilitation

A systematic review of measures of self-reported adherence to unsupervised home-based rehabilitation exercise programmes, and their psychometric properties.

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Key words: Adherence, Self-report, Psychometric, Exercise, Rehabilitation

Word Count: 3,350

Abstract

Background
Adherence is an important factor contributing to the effectiveness of exercise-based rehabilitation. However, there appears to be a lack of reliable, validated measures to assess self-reported adherence to prescribed but unsupervised home-based rehabilitation exercises.

Objectives
A systematic review was conducted to establish what measures were available and to evaluate their psychometric properties.

Data Sources
Medline, Embase, PsycINFO CINAHL (June 2013) and the Cochrane library were searched (September 2013). Reference lists from articles meeting the inclusion criteria were checked to ensure all relevant papers were included.

Study selection
To be included articles had to: be available in English; use a self-report measure of adherence in relation to a prescribed but unsupervised home based-exercise or physical rehabilitation programme; involve participants over the age of 18. All health conditions and clinical populations were included.

Data extraction
Descriptive data reported were collated on a data extraction sheet. The measures were evaluated in terms of eight psychometric quality criteria.

Results
Fifty eight studies were included, reporting 61 different measures including 29 questionnaires, 29 logs, two visual analogue scales (VAS) and one tally counter. Only two measures scored positively for one psychometric property (content validity). The majority of measures had no reported validity or reliability testing.

Conclusions
The results expose a gap in the literature for well-developed measures that capture self-reported adherence to prescribed but unsupervised home-based rehabilitation exercises.

Strengths and limitations of this study

- This study highlights the paucity of reported, validated and reliable self-report measures for unsupervised, exercise-based rehabilitation adherence.
- Despite the number and breadth of measures reported, this study reveals only two measures which conclusively possessed any psychometric property.
- The study also establishes that the vast majority of measures highlighted in this review had not reportedly undergone any psychometric testing of reliability and validity. However this does not necessarily mean testing was not conducted.
- The lack of reporting regarding tests conducted on a measure does not assume that all measures have poor psychometric properties.

Introduction

Exercise based rehabilitation improves fitness and functional ability for people with long term conditions. [1] These outcomes are hugely important because they make a substantial difference to people's lives and to the economy. However prescribed exercise programmes often comprise a part of home based rehabilitation or self-management for long term conditions and are typically unsupervised by health professionals. Therefore it is unclear if any exercise occurs, if people have engaged in enough exercise to obtain the therapeutic benefit, or if they are sustaining their exercise levels for long enough to self-manage their condition.[2] Finding a way to know what patients are doing and how much they are doing is consequently important and one method that has been used is self-report. The systematic review therefore set out to identify what self-report measures have been used for assessing adherence to home based unsupervised exercises, as this focused review has not been conducted before.

Self-report measures can over-estimate as well as under-estimate how much people actually do.[3] Individuals' attitudes and beliefs, coupled with the beliefs of people they interact with, influence intention to exercise,[4] as well as actual levels of exercise adherence. Replies to questions asked about adherence may reflect what the person feels is the desired response rather than a true appraisal of their behaviour, giving a falsely positive estimate of adherence.[5 6] This may be one reason why unsupervised home based exercise programmes are deemed ineffective, when in reality 'an insufficient regimen effect' has occurred.[7]

For the purposes of this review adherence is defined as; the degree behaviour corresponds with an agreed upon recommendation. It is a complex and multidimensional construct that can be affected by a number of factors related to the condition, the person (such as forgetfulness, self-efficacy, attitudes, mood states such as depression and socioeconomic status) and the relationship between the person and healthcare professional.[8]

While there are self-report questionnaires that have been developed and validated for medication based adherence,[9-11] there appears to be a paucity of psychometrically sound self-report measures for recording adherence in the specific context of prescribed but unsupervised home-based rehabilitation exercises for people with long term physical conditions. Thus the aims of this systematic review were to: identify self-report measures of adherence that have been used in this context and to critically evaluate the psychometric properties of these measures.

Methods

Selection Criteria

The inclusion criteria were kept broad to ensure all studies pertaining to measuring exercise adherence were identified. However articles had to:

- Include participants aged 18 and over;
- Use a self-report measure of exercise adherence;

- Indicate that the exercise was in relation to an unsupervised home-based exercise programme that was prescribed as part of a rehabilitation programme for someone with a long term physical condition.
- Be available in English.

There were no restrictions on included health conditions or adult sub-populations or study design. Modified versions of measures were included as were papers reporting separate psychometric evaluation of a measure already identified. Where a study used a measure that had previously been reported, only the original citation was included. No limit was made on the type of measure. Studies that used session attendance as a measure of adherence or clinician-reported adherence were excluded as were papers published only as abstracts.

Information sources

Papers were identified from: Medline (1946 onwards); Embase (1980 onwards) and PsycINFO (1806 onwards) in the Ovid platform; and CINAHL (1981 onwards) in the NHS (UK) platform. These searches were originally performed on the 19th January 2012 and updated on June 27th 2013. The Cochrane database was searched on the 7th of February 2013 and updated on the 9th September 2013. Studies were limited to those that were published in English involving humans, over the age of 18. Hand searching of included studies was also undertaken.

Search Strategy

The search strategy included combinations of keywords and MESH terms which were exploded. Truncations of words were used and search terms were prefixed with 'ti, ab' to ensure the results would contain these words in the abstract. The strategy was modified for CINAHL and the Cochrane database due to different search platforms and MESH terms. Appendix 1 illustrates the detailed search strategy.

Study selection

Titles and abstracts were independently screened for eligibility by two reviewers (JB, VG). Eligible papers were gathered in full text and independently screened by the same reviewers. A third reviewer (SD) facilitated decision making when there were disagreements.

Data extraction

A data extraction sheet designed devised by TH for assessing musculoskeletal rehabilitation measures was modified for this study. Data were extracted regarding: the name of the measure, how the measure was devised, a description of the measure, how the measure was scored, the purpose of the study and the number of participants and the population in which the measure was being used. If the information was not evidenced in the papers 'N/R' was used to illustrate the information was not reported. The quality of the measures was assessed using the Quality Criteria developed by Terwee et al.[12] Each psychometric property was rated either positive, intermediate, negative or zero (Table 1). Data were extracted by one reviewer (JB) and checked by a second (VG).

Results

The search identified 2264 citations (Figure 1). Fifty eight papers were included, reporting 58 studies and 61 measures of adherence, of which there were 29 questionnaires, 29 logs/dairies, two visual analogue scales (VAS) and one tally counter. Data from 7,424 participants were included. Where reported, there were a total of 2093 males and 2911 females with a mean age of 55.7 years (Standard deviation = 12.4 years). The study populations included those with cancer,[13 14] musculoskeletal,[15-37] cardiovascular,[38-46] respiratory,[47-49] neurological,[50] genitourinary,[51-55] and, endocrine conditions,[56] in addition to war veterans,[57] older people,[58-61] those undergoing surgery,[62-65] those receiving voice therapy,[66] and, sedentary people.[67-70] Appendix 2 provides a detailed description of each included study.

Table 1 provides an overview of each psychometric property and the quality criteria assessment for the included measures. Only two measures achieved a positive rating from the range of psychometric properties, and these were both for content validity.[39 60] The Adherence to Exercise Scale for Older People (AESOP),[60] was developed using two existing scales, the Self-Efficacy for Exercise and the Outcome Expectations for Exercise scales,[71-73] as a basis for developing items that were subsequently evaluated with five older people, modified and re-evaluated with a further five older people. The Heart Failure Compliance Questionnaire,[39] used qualitative interviews with three patients with heart failure to develop questionnaire items that were tested with six specialist nurses, a sociologist and ten people with heart failure.

Table 1: Psychometric properties and quality assessment [15] of the measures reported by the included studies.

Quality Rating	Content Validity	Internal Consistency	Criterion Validity	Construct Validity	Agreement	Reliability	Responsiveness	Floor and Ceiling Effects	Interpretability
Positive[a]	2	0	0	0	0	0	0	0	0
Intermediate[b]	6	5	3	18	0	3	0	1	17
Negative[c]	9	0	0	3	0	0	0	1	*
Zero[d]	44	56	58	40	61	58	61	59	44

* No negative option for this construct

Key

[a]A Positive rating for the adherence measure was obtained when tests for the property in question addressed all the criteria to a satisfactory extent

[b]An Intermediate rating for the adherence measure was obtained when some aspects of the criteria for a positive rating were completed, but not all, or there was doubt about the method or design used to test the psychometric property

[c]A Negative rating for the adherence measure was obtained when the property being assessed proved to be non-existent or fell below specified thresholds despite the method and design used to test psychometric property being sufficient

[d]A zero rating for the adherence measure was obtained when there was no information in the paper or no evidence that this psychometric property had been considered.

Most measures had no evidence that they had undergone any sort of psychometric evaluation although a small number of researchers had attempted to evaluate some measurement properties but used dubious methods or the property being assessed fell below suitable quality thresholds as determined by Terwee et al.[12] In addition, some authors referenced that their measure had established psychometric properties but then modified the scale or used it with a completely different population without re-examining the properties in the revised scale. No studies assessed agreement or responsiveness. Appendix 3 provides a detailed account of each measure in terms of psychometric properties and our quality rating.

Discussion

Principle findings

This is the first systematic review to identify and evaluate measures of self-reported adherence to prescribed, unsupervised home-based rehabilitation exercises for a range of health conditions and populations. We found 58 studies reporting on 61 measures and many of the measures shared similarities but almost all lacked any psychometric validation. This is an absurd and messy situation for appraising the benefits of unsupervised home based exercise rehabilitation.

A few measures had undergone some assessment of measurement properties but these were not considered to meet the quality criteria set by Terwee et al.[12] For example, one study,[19] reported a Pearson correlation coefficient to determine reliability but this is deemed unacceptable due to systematic differences not being accounted for.[12] Two measures,[39 60] were found to have content validity. This is a relatively straight forward property to establish so it is somewhat surprising that more measures did not rate positively for this. Terwee et al.[12] states a measure should only be used if content validity is satisfactory. If content validity is not considered in the measures' construction, it will not be known if the questions are relevant and comprehensive for the target population. Content validity also impacts on floor and ceiling effects and despite the AESOP questionnaire having content validity it was found to have a very strong ceiling effect.

In addition some authors appeared to assume that a measure can be modified and any psychometric properties from the original measure would still stand; however changing a measure may completely undermine any prior assumptions about its validity. This disparity was found when evaluating the internal consistency of one measure,[22 23] which was then modified in another study by adding two questions.[16] This resulted in Cronbach's alphas of 0.93 (original measure) and only 0.63 in the modified measure.

Strengths and limitations

This review had clear inclusion and exclusion criteria and used a robust quality criteria tool to assess the reporting of psychometric properties of the measures. Although the quality criteria tool was designed for health status questionnaires and not specifically for adherence measures we believe it was the best tool available.

A limitation was that only papers available in English were included as there were no resources for a translation. This potential publication bias may impact on the generalisability of our review to non-English speaking countries. Another important aspect to note is that just

because psychometric testing was not reported or was ambiguous this does not mean that it was not conducted or is not of a high quality. We could have overcome some aspects of this by contacting authors for any unpublished supporting data regarding their measure, if it was available. Although this may have aided our ability to judge the quality of the measure's properties, it would not guarantee that the properties were of a high standard.

Comparison with existing literature

Self-reported medication adherence is perhaps the most advanced in the field with questionnaires having been developed and validated although there remains no gold standard measure.[9] A recent review of adherence measures for anti-hypertensive medication suggested 39% of measures indicated some level of reliability and validity, but 33% had undergone no psychometric testing. [74]

Alternative methods of assessing adherence to exercise-based rehabilitation do exist and include attendance at appointments,[75] although this does not necessarily mean the individual is completing the activities they are meant to be doing. Alternatively adherence could be assessed by others; for example the Sports Injury Rehabilitation Adherence Scale (SIRAS)[76] comprises a therapist or trainer-rated observation of whether a patient has completed their exercises as instructed. Due to the supervisory element of SIRAS, it is possible that the individual may no longer feel they have a choice to adhere; the constant supervision requires their compliance not their adherence. Conversely in-clinic observations need not be obvious and so could provide insight into an individual's level of motivation to adhere. Either way the in-clinic assessment does not necessarily reflect what happens in an unsupervised environment. In addition to observation by another, objective measurement methods can be used, such as accelerometers to record physical activity.[77] However these also have limitations for assessing adherence, especially longer term or with large clinical groups, as the devices are expensive and require the participant to adhere to wearing them. In addition the devices act as 'supervisors' which may result in a false view of adherence as the individual may no longer feel they have the autonomy to choose whether or not to adhere.[11] Furthermore these devices do not easily capture the movements of therapeutic exercise. The rapid development of smart phone technology and apps may provide a future solution to this issue albeit still at some cost. At present it is clear that there is no cheap and easily available gold standard measurement of unsupervised exercise-based rehabilitation adherence and so, even with its inherent problems, self-report remains an important option.

Implications for practice and future research

There are a large number of measures that presume to record adherence to prescribed unsupervised home-based rehabilitation exercises but there is a shortage of measures that have been robustly validated. Whilst clinicians generally believe they have some idea as to how adherent their patients are, it is unlikely that their clinical judgement is completely accurate particularly for the unobserved element of an exercise programme. Coupled with the lack of well-developed measures it becomes very difficult for clinicians to determine if an exercise regime being prescribed is ineffective, and the prescription needs adjusting, or if the individual is non-adherent and requires further support to facilitate uptake and maintenance

of their exercise programme. A self-report measure that is able to identify patients who require this extra support will be clinically useful however this would also act as a potential confounding factor for measuring adherence (as it could act as a reminder and hence facilitate adherence).

This review has focused on the problems of self-reported exercise adherence measurement and the findings support the urgent need to develop valid and reliable measures that can be used for research purposes, at least in the first instance. It may be possible to develop such measures as suitable adherence assessment tools that will aid clinicians to support patients to undertake optimal exercise doses. Ultimately the best strategy is likely to be a combination of measures across the spectrum of objective, clinician assessed through to patient self-report.

Funding

This research was funded by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care (CLAHRC) for the South West Peninsula. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health in England.

Contributorship statement

The idea for the article was devised by SD in conjunction with VG and RJS with JB being the guarantor of this study. The search Strategy was devised by JB with input from SD, VG, RJS and TH with JB then running the literature searches. Screening by title, abstracts and full text applying the inclusion and exclusion criteria was conducted by JB and VG with SD available in the case of disagreement. JB and VG also conducted the data extraction using an adaptation of a form supplied by TH. The compilation of the data was conducted by JB. JB, VG and SD drafted the manuscripts with substantial input from RJS and TH which was then critically revised and refined by all authors

Competing interests

All authors have completed the ICMJE uniform disclosure form atwww.icmje.org/coi_disclosure.pdf and declare: JB, VG and SD had financial support from the National Institute for Health Research (NIHR) for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Data Sharing Statement

No additional data available

Copyright

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A systematic review of measures of self-reported adherence to unsupervised home-based rehabilitation exercise programmes, and their psychometric properties.

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Key words: Adherence, Self-report, Psychometric, Exercise, Rehabilitation

Word Count: 3,350

Abstract

Background
Adherence is an important factor contributing to the effectiveness of exercise-based rehabilitation. However, there appears to be a lack of reliable, validated measures to assess self-reported adherence to prescribed but unsupervised home-based rehabilitation exercises.

Objectives
A systematic review was conducted to establish what measures were available and to evaluate their psychometric properties.

Data Sources
Medline, Embase, PsycINFO CINAHL (June 2013) and the Cochrane library were searched (September 2013). Reference lists from articles meeting the inclusion criteria were checked to ensure all relevant papers were included.

Study selection
To be included articles had to: be available in English; use a self-report measure of adherence in relation to a prescribed but unsupervised home based-exercise or physical rehabilitation programme; involve participants over the age of 18. All health conditions and clinical populations were included.

Data extraction
Descriptive data reported were collated on a data extraction sheet. The measures were evaluated in terms of eight psychometric quality criteria.

Results
Fifty eight studies were included, reporting 61 different measures including 29 questionnaires, 29 logs, two visual analogue scales (VAS) and one tally counter. Only two measures scored positively for one psychometric property (content validity). The majority of measures had no reported validity or reliability testing.

Conclusions
The results expose a gap in the literature for well-developed measures that capture self-reported adherence to prescribed but unsupervised home-based rehabilitation exercises.

Strengths and limitations of this study

- This study highlights the paucity of reported, validated and reliable self-report measures for unsupervised, exercise-based rehabilitation adherence.
- Despite the number and breadth of measures reported, this study reveals only two measures which conclusively possessed any psychometric property.

- The study also establishes that the vast majority of measures highlighted in this review had not reportedly undergone any psychometric testing of reliability and validity. However this does not necessarily mean testing was not conducted.

- The lack of reporting regarding tests conducted on a measure does not assume that all measures have poor psychometric properties.

Introduction

Exercise based rehabilitation improves fitness and functional ability for people with long term conditions. [1] These outcomes are hugely important because they make a substantial difference to people's lives and to the economy. However prescribed exercise programmes often comprise a part of home based rehabilitation or self-management for long term conditions and are typically unsupervised by health professionals. Therefore it is unclear if any exercise occurs, if people have engaged in enough exercise to obtain the therapeutic benefit, or if they are sustaining their exercise levels for long enough to self-manage their condition.[2] Finding a way to know what patients are doing and how much they are doing is consequently important and one method that has been used is self-report. The systematic review therefore set out to identify what self-report measures have been used for assessing adherence to home based unsupervised exercises, as this focused review has not been conducted before.

Self-report measures can over-estimate as well as under-estimate how much people actually do.[3] Individuals' attitudes and beliefs, coupled with the beliefs of people they interact with, influence intention to exercise,[4] as well as actual levels of exercise adherence. Replies to questions asked about adherence may reflect what the person feels is the desired response rather than a true appraisal of their behaviour, giving a falsely positive estimate of adherence.[5 6] This may be one reason why unsupervised home based exercise programmes are deemed ineffective, when in reality 'an insufficient regimen effect' has occurred.[7]

For the purposes of this review adherence is defined as; the degree behaviour corresponds with an agreed upon recommendation. It is a complex and multidimensional construct that can be affected by a number of factors related to the condition, the person (such as forgetfulness, self-efficacy, attitudes, mood states such as depression and socioeconomic status) and the relationship between the person and healthcare professional.[8]

While there are self-report questionnaires that have been developed and validated for medication based adherence,[9-11] there appears to be a paucity of psychometrically sound self-report measures for recording adherence in the specific context of prescribed but unsupervised home-based rehabilitation exercises for people with long term physical conditions. Thus the aims of this systematic review were to: identify self-report measures of adherence that have been used in this context and to critically evaluate the psychometric properties of these measures.

Methods

Selection Criteria

The inclusion criteria were kept broad to ensure all studies pertaining to measuring exercise adherence were identified. However articles had to:

- Include participants aged 18 and over;
- Use a self-report measure of exercise adherence;
- Indicate that the exercise was in relation to an unsupervised home-based exercise programme that was prescribed as part of a rehabilitation programme for someone with a long term physical condition.
- Be available in English.

There were no restrictions on included health conditions or adult sub-populations or study design. Modified versions of measures were included as were papers reporting separate psychometric evaluation of a measure already identified. Where a study used a measure that had previously been reported, only the original citation was included. No limit was made on the type of measure. Studies that used session attendance as a measure of adherence or clinician-reported adherence were excluded as were papers published only as abstracts.

Information sources

Papers were identified from: Medline (1946 onwards); Embase (1980 onwards) and PsycINFO (1806 onwards) in the Ovid platform; and CINAHL (1981 onwards) in the NHS (UK) platform. These searches were originally performed on the 19th January 2012 and updated on June 27th 2013. The Cochrane database was searched on the 7th of February 2013 and updated on the 9th September 2013. Studies were limited to those that were published in English involving humans, over the age of 18. Hand searching of included studies was also undertaken.

Search Strategy

The search strategy included combinations of keywords and MESH terms which were exploded. Truncations of words were used and search terms were prefixed with 'ti, ab' to ensure the results would contain these words in the abstract. The strategy was modified for CINAHL and the Cochrane database due to different search platforms and MESH terms. Appendix 1 illustrates the detailed search strategy.

Study selection

Titles and abstracts were independently screened for eligibility by two reviewers (JB, VG). Eligible papers were gathered in full text and independently screened by the same reviewers. A third reviewer (SD) facilitated decision making when there were disagreements.

Data extraction

A data extraction sheet designed devised by TH for assessing musculoskeletal rehabilitation measures was modified for this study. Data were extracted regarding: the name of the measure, how the measure was devised, a description of the measure, how the measure was scored, the purpose of the study and the number of participants and the population in which the measure was being used. If the information was not evidenced in the papers 'N/R'

was used to illustrate the information was not reported. The quality of the measures was assessed using the Quality Criteria developed by Terwee et al.[12] Each psychometric property was rated either positive, intermediate, negative or zero (Table 1). Data were extracted by one reviewer (JB) and checked by a second (VG).

Results

The search identified 2264 citations (Figure 1). Fifty eight papers were included, reporting 58 studies and 61 measures of adherence, of which there were 29 questionnaires, 29 logs/dairies, two visual analogue scales (VAS) and one tally counter. Data from 7,424 participants were included. Where reported, there were a total of 2093 males and 2911 females with a mean age of 55.7 years (Standard deviation = 12.4 years). The study populations included those with cancer,[13 14] musculoskeletal,[15-37] cardiovascular,[38-46] respiratory,[47-49] neurological,[50] genitourinary,[51-55] and, endocrine conditions,[56] in addition to war veterans,[57] older people,[58-61] those undergoing surgery,[62-65] those receiving voice therapy,[66] and, sedentary people.[67-70] Appendix 2 provides a detailed description of each included study.

Table 1 provides an overview of each psychometric property and the quality criteria assessment for the included measures. Only two measures achieved a positive rating from the range of psychometric properties, and these were both for content validity.[39 60] The Adherence to Exercise Scale for Older People (AESOP),[60] was developed using two existing scales, the Self-Efficacy for Exercise and the Outcome Expectations for Exercise scales,[71-73] as a basis for developing items that were subsequently evaluated with five older people, modified and re-evaluated with a further five older people. The Heart Failure Compliance Questionnaire,[39] used qualitative interviews with three patients with heart failure to develop questionnaire items that were tested with six specialist nurses, a sociologist and ten people with heart failure.

Table 1: Psychometric properties and quality assessment [15] of the measures reported by the included studies.

Quality Rating	Content Validity	Internal Consistency	Criterion Validity	Construct Validity	Agreement	Reliability	Responsiveness	Floor and Ceiling Effects	Interpretability
Positive[a]	2	0	0	0	0	0	0	0	0
Intermediate[b]	6	5	3	18	0	3	0	1	17
Negative[c]	9	0	0	3	0	0	0	1	*
Zero[d]	44	56	58	40	61	58	61	59	44

* No negative option for this construct

Key

[a]A Positive rating for the adherence measure was obtained when tests for the property in question addressed all the criteria to a satisfactory extent

[b]An Intermediate rating for the adherence measure was obtained when some aspects of the criteria for a positive rating were completed, but not all, or there was doubt about the method or design used to test the psychometric property

[c]A Negative rating for the adherence measure was obtained when the property being assessed proved to be non-existent or fell below specified thresholds despite the method and design used to test psychometric property being sufficient

[d]A zero rating for the adherence measure was obtained when there was no information in the paper or no evidence that this psychometric property had been considered.

Most measures had no evidence that they had undergone any sort of psychometric evaluation although a small number of researchers had attempted to evaluate some measurement properties but used dubious methods or the property being assessed fell below suitable quality thresholds as determined by Terwee et al.[12] In addition, some authors referenced that their measure had established psychometric properties but then modified the scale or used it with a completely different population without re-examining the properties in the revised scale. No studies assessed agreement or responsiveness. Appendix 3 provides a detailed account of each measure in terms of psychometric properties and our quality rating.

Discussion

Principle findings

This is the first systematic review to identify and evaluate measures of self-reported adherence to prescribed, unsupervised home-based rehabilitation exercises for a range of health conditions and populations. We found 58 studies reporting on 61 measures and many of the measures shared similarities but almost all lacked any psychometric validation. This is an absurd and messy situation for appraising the benefits of unsupervised home based exercise rehabilitation.

A few measures had undergone some assessment of measurement properties but these were not considered to meet the quality criteria set by Terwee et al.[12] For example, one study,[19] reported a Pearson correlation coefficient to determine reliability but this is deemed unacceptable due to systematic differences not being accounted for.[12] Two measures,[39 60] were found to have content validity. This is a relatively straight forward property to establish so it is somewhat surprising that more measures did not rate positively for this. Terwee et al.[12] states a measure should only be used if content validity is satisfactory. If content validity is not considered in the measures' construction, it will not be known if the questions are relevant and comprehensive for the target population. Content validity also impacts on floor and ceiling effects and despite the AESOP questionnaire having content validity it was found to have a very strong ceiling effect.

In addition some authors appeared to assume that a measure can be modified and any psychometric properties from the original measure would still stand; however changing a measure may completely undermine any prior assumptions about its validity. This disparity was found when evaluating the internal consistency of one measure,[22 23] which was then modified in another study by adding two questions.[16] This resulted in Cronbach's alphas of 0.93 (original measure) and only 0.63 in the modified measure.

Strengths and limitations

This review had clear inclusion and exclusion criteria and used a robust quality criteria tool to assess the reporting of psychometric properties of the measures. Although the quality criteria tool was designed for health status questionnaires and not specifically for adherence measures we believe it was the best tool available.

A limitation was that only papers available in English were included as there were no resources for a translation. This potential publication bias may impact on the generalisability of our review to non-English speaking countries. Another important aspect to note is that just

because psychometric testing was not reported or was ambiguous this does not mean that it was not conducted or is not of a high quality. We could have overcome some aspects of this by contacting authors for any unpublished supporting data regarding their measure, if it was available. Although this may have aided our ability to judge the quality of the measure's properties, it would not guarantee that the properties were of a high standard.

Comparison with existing literature

Self-reported medication adherence is perhaps the most advanced in the field with questionnaires having been developed and validated although there remains no gold standard measure.[9] A recent review of adherence measures for anti-hypertensive medication suggested 39% of measures indicated some level of reliability and validity, but 33% had undergone no psychometric testing. [74]

Alternative methods of assessing adherence to exercise-based rehabilitation do exist and include attendance at appointments,[75] although this does not necessarily mean the individual is completing the activities they are meant to be doing. Alternatively adherence could be assessed by others; for example the Sports Injury Rehabilitation Adherence Scale (SIRAS)[76] comprises a therapist or trainer-rated observation of whether a patient has completed their exercises as instructed. Due to the supervisory element of SIRAS, it is possible that the individual may no longer feel they have a choice to adhere; the constant supervision requires their compliance not their adherence. Conversely in-clinic observations need not be obvious and so could provide insight into an individual's level of motivation to adhere. Either way the in-clinic assessment does not necessarily reflect what happens in an unsupervised environment. In addition to observation by another, objective measurement methods can be used, such as accelerometers to record physical activity.[77] However these also have limitations for assessing adherence, especially longer term or with large clinical groups, as the devices are expensive and require the participant to adhere to wearing them. In addition the devices act as 'supervisors' which may result in a false view of adherence as the individual may no longer feel they have the autonomy to choose whether or not to adhere.[11] Furthermore these devices do not easily capture the movements of therapeutic exercise. The rapid development of smart phone technology and apps may provide a future solution to this issue albeit still at some cost. At present it is clear that there is no cheap and easily available gold standard measurement of unsupervised exercise-based rehabilitation adherence and so, even with its inherent problems, self-report remains an important option.

Implications for practice and future research

There are a large number of measures that presume to record adherence to prescribed unsupervised home-based rehabilitation exercises but there is a shortage of measures that have been robustly validated. Whilst clinicians generally believe they have some idea as to how adherent their patients are, it is unlikely that their clinical judgement is completely accurate particularly for the unobserved element of an exercise programme. Coupled with the lack of well-developed measures it becomes very difficult for clinicians to determine if an exercise regime being prescribed is ineffective, and the prescription needs adjusting, or if the individual is non-adherent and requires further support to facilitate uptake and maintenance

of their exercise programme. A self-report measure that is able to identify patients who require this extra support will be clinically useful however this would also act as a potential confounding factor for measuring adherence (as it could act as a reminder and hence facilitate adherence).

This review has focused on the problems of self-reported exercise adherence measurement and the findings support the urgent need to develop valid and reliable measures that can be used for research purposes, at least in the first instance. It may be possible to develop such measures as suitable adherence assessment tools that will aid clinicians to support patients to undertake optimal exercise doses. Ultimately the best strategy is likely to be a combination of measures across the spectrum of objective, clinician assessed through to patient self-report.

Competing interests

All authors have completed the ICMJE uniform disclosure form atwww.icmje.org/coi_disclosure.pdf and declare: JB, VG and SD had financial support from the National Institute for Health Research (NIHR) for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributorship statement

The idea for the article was devised by SD in conjunction with VG and RJS with JB being the guarantor of this study. The search Strategy was devised by JB with input from SD, VG, RJS and TH with JB then running the literature searches. Screening by title, abstracts and full text applying the inclusion and exclusion criteria was conducted by JB and VG with SD available in the case of disagreement. JB and VG also conducted the data extraction using an adaptation of a form supplied by TH. The compilation of the data was conducted by JB. JB, VG and SD drafted the manuscripts with substantial input from RJS and TH which was then critically revised and refined by all authors

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Funding

This research was funded by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care (CLAHRC) for the South West Peninsula. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health in England.

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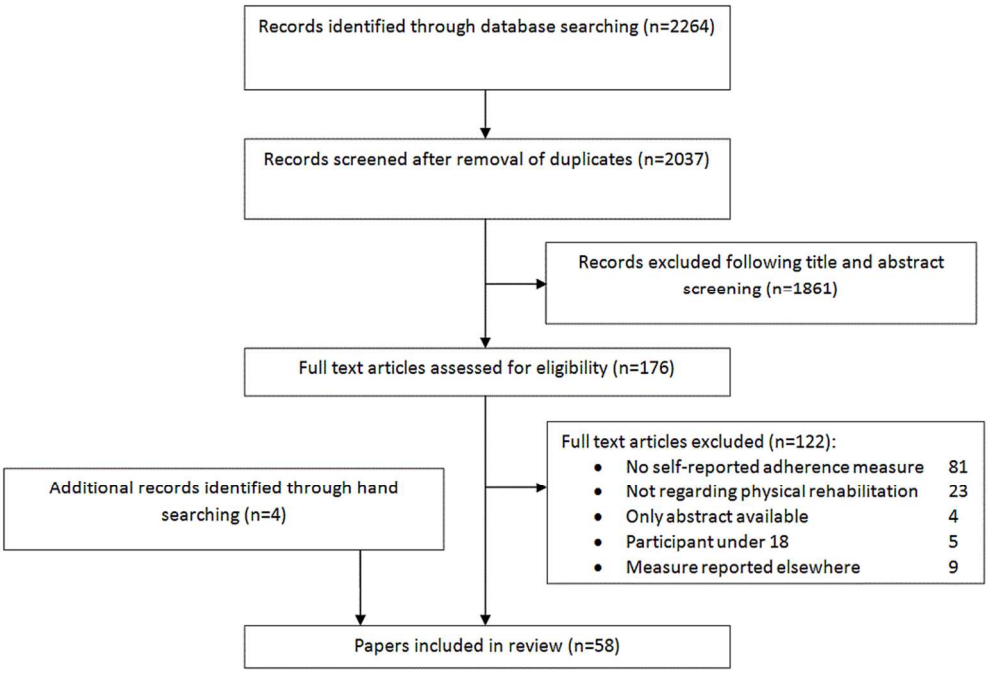

Figure 1 Flow diagram outlining the process of selection of papers for the systematic review

90x69mm (300 x 300 DPI)

Appendix 1.

Search strategy with limiters for Ovid SP (Medline (R))

1. exp Patient Compliance/
2. patient compliance.ti,ab.
3. ''medic* adhere*''.ti,ab.
4. exp Medication Adherence/
5. 1 or 2
6. 3 or 4
7. (1 or 2) not (3 or 4)
8. exp exercise therapy/ or exp rehabilitation/ or self care/ or exp self administration/
9. exercise therapy.ti,ab.
10. exercise.ti,ab.
11. rehabilitat*.ti,ab.
12. ''self care''.ti,ab.
13. ''self administration''.ti,ab.
14. exp exercise/ or exp muscle stretching exercises/ or exp resistance training/
15. exp Exercise Tolerance/
16. ''physical activity''.ti,ab.
17. "attitude of health personnel"/ or exp attitude to health/
18. value*.ti,ab.
19. attitude*.ti,ab.
20. belief*.ti,ab.
21. (functional adj3 (therapy or restor*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
22. functional therap*.ti,ab.
23. exp Questionnaires/cl, mt, st, td [Classification, Methods, Standards, Trends]
24. exp Self Report/st, ut [Standards, Utilization]
25. questionnaire*.ti,ab.
26. ''self report''.ti,ab.
27. ''patient report''.ti,ab.
28. exp exercise/ or exp physical fitness/
29. 17 or 18 or 19 or 20
30. 23 or 24 or 25 or 26 or 27
31. 7 or 29
32. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 21 or 22 or 28
33. 30 and 31 and 32

(**Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R)** 1946 to Present)

limit 28 to (english language and humans and ("all adult (19 plus years)" or "adolescent (13 to 18 years)"))

Appendix 2. (Table 2a, 2b, 2c and 2d) All measures divided by type, stating the lead author, condition of the participants and pertinent points regarding the measure

2a. Questionnaire based measures of adherence

Author and Condition	[a]Questionnaire name, [b]how devised, [c]description of measure, [d]how scored, , [e] purpose of study [f] number of participants and population, NR= not reported
Barnowski 1998 [62] Surgery: Carpel tunnel	[a] NR [b] NR [c] Questionnaire conducted as an interview. Questions asked pertaining to home exercise performance, frequency, and obstacles concerning the exercise programme. Participants then rated their weekly adherence from week 1-6 on a scale ranging from 3=compliant to 0= non-compliant [d] Score was totalled which could range from 0-18 over the 6 weeks [e] To examine the consequence of sex, age, job and going back to work on the recovery of grip strength after surgery for carpel tunnel and the relationship concerning compliance with exercises and the recovery of grip strength [f] 11 Individuals undergoing carpel tunnel surgery
Bassett 2011 [16] Musculoskeletal conditions: Ankle sprain	[a] NR but referred to as a self-report scale [b] NR [c] Scale listed the 5 methods of treatment; exercise, icing, not participating in activities that could be damaging to recovery, strapping of ankle, resting and elevating ankle [d] Participants rated adherence 1-5 for each applicable method of treatment [e] To assess the effect of an education intervention based around Protection Motivation Theory for patients with ankle sprains and the association between the patients intentions, physiotherapy beliefs, adherence, and the ankle injury and function [f] 69 individuals with ankle sprains
Bennell 2012 [17] Musculoskeletal conditions: Osteoarthritis	[a] NR but referred to as a self- report questionnaire [b] NR [c] Two questions asked at 3,6,9,12,15 and 18 months; one pertaining to the frequency the exercises was performed during the past two weeks, for the second question the participant is asked to rate their adherence to the home based exercises between 1= 'not at all'-11= 'completely as instructed' . [d] NR [e] To assess the effectiveness -both clinical and cost- of coaching over the telephone in addition to physiotherapy for the target population [f] 0 participants as a prospective study but would hope to recruit 168 participants with knee osteoarthritis
Borello-France 2010 [52]	[a] NR [b] NR but based on questionnaire by Sluijs et al '93

Genitourinary conditions: Urge incontinence	[c] Completed at clinical centre at visit number 2, 3 and 4 out of 4 visits and throughout year at 2,4, 6 and 12 months with minor alterations to make it relevant during the follow-up period. Consisted of 9 questions; 2 questions about frequency of carrying out exercises and completing all repetitions with choice of 4 answers. 7 questions regarding exercise barriers with the choices of 'yes', 'no' and 'uncertain' [d] averages were determined based on number of exercises performed per day and number of days per week the exercises were conducted divided by 7. An average of all the means was taken over the intervention and follow-up. [e] To depict adherence to pelvic floor exercises, look at the barriers present preventing exercises being conducted, and detect factors associated with adherence to the exercises [f] 154 females with urinary incontinence
Chen 2009 [54] Genitourinary conditions: Urinary incontinence	[a] NR [b] NR but devised by author [c] Questionnaire consisted of 3 items. Items 1 and 2 regard time spent and number of exercises completed on a 5 and 6 item scale respectively. Item 3 was a Visual Analogue Scale (VAS) ranging from 0-10 where participants rate compliance. Completed face to face if possible but could also be posted. [d] The three items were combined with a possible range scoring between 2-21 [e] To construct a model depicting direct and indirect sources of adherence and then to test the model [f] 106 female participants with urinary incontinance
Courneya 2004 [13] Cancer: Colorectal	[a] Leisure Score Index (LSI) modified from the Godin Leisure-Time Exercise Questionnaire [b] Added a question to the pre-existing questions regarding the average length of time spent exercising [c] 3 open-ended questions regarding the participants average frequency and intensity of exercise. The modification referred to including a question regarding average time spent exercising. Participants complete the measure weekly over the telephone talking to a researcher [d] The average frequency of exercise was multiplied by the average duration of exercise at 3 intensity levels (mild, moderate and strenuous). The minutes spent in moderate and strenuous exercise will then be summed. The moderate and strenuous level minutes were then combined [e] To explore predictors of adherence to exercise and exercise contamination in the target population [f] 102 participants with colorectal cancer
Dobkin 2008 [19] Musculoskeletal conditions: Fibromyalgia	[a] General Adherence Scale (GAS) [b] Used previously in hypertensive medication adherence but not in exercise rehabilitation adherence. [c] a 6 point 1-6 scale regarding general inclination to adhere. Self-reported by participants Carried out at 1, 2 and 3 months. Regarding adherence in the past month [d] The average of the 5 items was calculated and then converted into a

	number ranging 0-100 [e] To describe adherence, determine predictors of adherence and apprise the association between adherence to treatment and outcome in individuals with fibromyalgia [f] 63 participants with Fibromyalgia
	[a] Specific Adherence Scale (SAS) [b] Devised by authors [c] 17 items on 4 point 0-3 scale regarding adherence in the past week. Self-reported by participants and carried out at months 1,2 and 3 [d] The average of the 17 items was calculated and then converted into a number ranging 0-100 [e] To describe adherence, determine predictors of adherence and apprise the association between adherence to treatment and outcome in individuals with fibromyalgia [f] 63 participants with Fibromyalgia
Evangelista 2001 [39] Cardiovascular Conditions: Heart failure	[a] The Heart Failure Compliance Questionnaire [b] based on an existing measure for myocardial infarction. Three heart failure patients were interviewed to create items that were relevant to the target population and decide what other themes the questionnaire should consist of. This was then reviewed by six specialist nurses, one sociologist and ten participants involved in the study regarding comprehensiveness and length of the questionnaire [c] 6 subsections regarding health behaviours were on the questionnaire. Participants responded on a 5 point scale how important they rated each health behaviour. They then had to rate their overall adherence on a 5 point scale. [d] The mean was calculated for each health behaviour and a combined score for all behaviours. Participants were deemed adherent if the combined score was above 75% [e] For health care workers to be able to identify non adherence and contributing factors that could lead to non-adherence [f] 82 participants with heart failure
Forkan 2006 [59] Older people: Impaired balance	[a] NR [b] Devised by authors based on literature and piloted on the target population and physical therapists [c] A 43 item questionnaire containing 1 open ended question and 7 subscales. [d] Subscale scores were summed together after responding on a 4 point scale [e] To ascertain adherence after discharge and the factors limiting adherence in addition to characterising involvement in the exercise [f] 175 participants who were over 65 years of age with impaired balance
Gallo 1997 [55] Genitourinary conditions: Stress urinary incontinence	[a] NR but referred to as a survey [b] Devised by authors for the study. Content validity was attempted using experts but no-one from the target population. Test-retest reliability was also attempted utilising 10 participants over a 1 week timespan. [c] Questionnaire with 4 sections pertaining to: number of times per day the exercises were conducted on average; the duration of time spent performing

	the exercises; the length of time each exercise held for; the reason for conducting exercises. Additional questions pertaining to use of cassette tape if in group utilising this intervention [d] NR [e] To determine if use of a cassette tape improves adherence to pelvic floor exercises in addition to; how many participants perform the exercises regularly, how many perform the exercises as prescribed, length of time spent performing the exercise programme, length of time each exercise held and, what prompts the individuals to conduct the exercises [f] 88 females with urinary incontinance
Hardage 2007 [60] Older people: Activity	[a] Adherence to Exercise Scale for Older Patients (AESOP) [b] Used items from pre-existing scales which could be modified, deleted or added to. This was then checked for applicability in the target population [c] The questionnaire was conducted as an interview with researcher. There were 3 subscales with a total of 45 items with were responded to on a 5 point scale [d] The scores for each of the subscales were summed separately resulting inn 3 totals [e] To produce a questionnaire to predict adherence to home based exercise [f] 50 participants aged 65 years old and over
Howard 2008 [21] Musculoskeletal conditions: Osteopathy patients	[a] No name [b] Devised by authors based on literature and attempts at face and content validity were made piloting the measure on 5 experts and 5 individuals from the target population [c] The self-report questionnaire comprises of 3 subscales; attitudes and experiences in regards to exercise and health; whether the participant had an exercise programme; whether the exercise programme had been carried out as specified. These were all scored on a 5 point scale. The final question required a yes or no answer regarding their completion of prescribed exercises [d] Each subscale was summed based on the scores from the 5 point scales [e] To devise a pilot measure to determine characteristics in the participants that may influence adherence to the prescribed exercise programmes and to investigate if adherent participants differed from non-adherent participants [f] 200 participants who were osteopathy patients
Jurkiewicz 2011 [41] Cardiovascular conditions: Stroke	[a] NR [b] Modified from a questionnaire by Marzolini and literature. State no validity or reliability testing was conducted but face validity was attempted by asking patients, physicians and cardiac rehabilitation staff pertinent questions regarding its relevance and range of questions [c] Self-report questionnaire with 16 items. Multiple choice for most questions but could write different response [d] NR [e] To determine factors affecting adherence to prescribed exercise programme conducted at home for the target population.

	[f] 14 stroke survivors
Khalil 2012 [50] Neurological conditions: Huntington's Disease	[a] NR [b] NR [c] Weekly telephone call to conduct verbal questionnaire. Asked if participants had conducted their exercises for the previous week; the frequency with which they had conducted them; which exercises they had carried out; if any difficulties had been encountered whilst conducting the exercise; and if the participant had any concerns [d] NR [e] To examine how individuals with Huntingdon's Disease and their carers perceived and used a specially developed exercise DVD [f] 15 participants with Huntington disease
Kim 2006 [56] Endocrine conditions: Type 2 diabetes	[a] NR [b] NR but based on 7- day physical activity questionnaire [c] recall questionnaire of all physical activity conducted during the last 7 days. Cues such as time of the day were used to aid recall. Participants were asked the frequency, duration and intensity with which they carried out each activity or exercise. [d] MET's were calculated for activates conducted and an overall physical activity energy score was obtained which depended on the amount of time and intensity of the exercises conducted [e] To determine the success of a web based and printed material Trans-Theoretical Model intervention programme for people with type 2 diabetes [f] 73 participants with type 2 diabetes
Levy 2008 [22] Musculoskeletal conditions: Tendonitis over use injury	[a]No name [b] NR but based on Bassett (2003) [c] The measure asked participants about adherence to exercises, cryotherapy and avoiding participating in activities that could aggravate injury on a 5 point scale 1= not at all- 5= as advised [d] scores for each question were summed together to arrive at an adherence total [e] To examine the associations between adherence to rehabilitation, age and perceived autonomy support [f] 70 participants with tendonitis overuse injury
Levy 2008 [23] Musculoskeletal conditions: Tendonitis over use injury	[a]No name [b] NR but based on Bassett (2003) [c] The measure asked participants about adherence to exercises, cryotherapy and avoiding participating in activities that could aggravate injury on a 5 point scale 1= not at all- 5= as advised [d] scores for each question were summed together to arrive at an adherence total [e] To attempt to predict adherence to rehabilitation by examining an adapted integrated psycho-social model [f] 70 participants with tendonitis overuse injury
Lysack	[a]NR

2005 [64] Surgery: Hip or knee replacements	[b] NR but the questionnaire was developed for the study [c] Conducted as Interview with researcher. Questions pertained to how regularly exercises were performed, difficulties with doing the exercises, any problems remembering to do the exercises, satisfaction with rehabilitation whilst an inpatient and satisfaction with therapeutic exercises [d] NR [e] To establish if adherence and satisfaction were improved if a personalised video tape with the exercises was used when completing the exercises at home as opposed to written instructions and verbal instruction [f] 40 participants with a hip or knee replacement
Mailloux 2006 [24] Musculoskeletal conditions: Chronic low back pain	[a] NR [b] NR [c] Recorded how often the exercises were performed per week out of 4 adherence caregories ranging from never to more than 5 times a week. Questionnaire completed at evaluation of the programme and at the 2 year follow up [d] NR [e] To try and establish if exercise behaviours were improved after rehabilitation and if they were maintained at follow up 2 years post rehabilitation. [f] 126 participants with back pain over 65 years of age
Marzolini 2010 [43] Cardiovascular conditions: Cardiac patients	[a] NR [b] devised by a physician, researcher and a cardiac rehabilitation clinician, in conjunction with a market research professional [c] Questionnaire contained 52 items [d] NR [e] To determine factors that may influence long term adherence to home based exercise programmes retrospectively [f] 358 participants who were cardiac patients
McCarthy 2004 [26] Musculoskeletal conditions: Osteoarthritis	[a] NR [b] NR [c] Questionnaire was completed at a 6 and 12 month assessment after the intervention. It comprised of four questions; how often are the exercises completed during a week over the past month; the length of time spent conducting the exercises; If they have stopped completing the exercises, the length of time since the individual last did the exercises, and, if the individuals felt there had been any change in physical activity levels during the last six months. There were multi-choice options. [d] NR [e] To determine the effect and cost of delivering an exercise programme to be conducted purely at home opposed to an exercise programme conducted at home in conjunction with a course of exercise classes [f] 214 participants with osteoarthritis
Medina-Mirapeix 2009 [27] Musculoskeletal	[a] NR [b] NR but adapted from Sluijs et al (1993) [c] Asked to record frequency and duration for conducting the exercise programme on a 5 point scale (never, seldom, often, almost always, always)

conditions: Neck and low back pain	for the past week 1 month after finishing physiotherapy [d] Individuals reporting the always, and almost always options on the were deemed as adherent [e] To examine the levels of adherence and if they differ when prescribed home based exercise in relation to the frequency and duration and if the frequency and duration could be predicted by certain factors. [f] 184 participants with neck and low back pain
Milne 2005 [29] Musculoskeletal conditions: Injured athletes	[a] NR [b] NR [c] Three areas in relation to rehabilitation were enquired about; the frequency, duration and quality of the exercises in five questions. The sections regarding frequency and duration each asked 2 questions regarding the physiotherapist's recommendation and what the participant did. 1 question regarded the quality, asking as a percentage how often the participant thought they did the exercises correctly. [d] Percentages were calculated for the two questions regarding frequency and the two regarding duration. Quality was already presented in percentage terms [e] To assess the validity of the Athletic Injury Self- Efficacy Questionnaire (AISEQ) and the predictive associations between the questionnaire measuring self-efficacy, adherence to rehabilitation and imagery use [f] 270 injured athletes participated
Rackwitz 2007 [30] Musculoskeletal conditions: Chronic low back pain	[a] NR [b] NR but devised by the author [c] Questions pertaining to number of days and length of time the rehabilitation programme was conducted during the past week. Questionnaire completed during the 8 week intervention and at a follow up at 3 months [d] NR [e] To assess if the rehabilitation programme was practical, what effects the programme may have and if people were adherent to the programme. [f] 92 participants with low back pain
Radtke 1989 [45] Cardiovascular conditions: Cardiac rehabilitation	[a]Exercise Compliance Questionnaire [b] Devised by author based on literature [c] 8 item measure. 6 questions about frequency, duration, intensity and method of exercise scored on a 5 point scale. 2 questions pertaining to before the heart attack [d] Scores were weighted for questions 1 to 6 which produced a number between 30 to 150. Individuals scoring less than 50 were deemed as low adherers and individuals scoring over 100 deemed high adherence [e] To establish if individuals conducted their home exercises as prescribed and if self-motivation affects their adherence to the prescribed home exercises [f] 28 participants who have suffered a myocardial infarction
Sluijs 1993 [35]	[a] NR [b] NR [c] 1 question asking if the participant regularly exercised in the past week.

Musculoskeletal conditions: Physiotherapy patients	Responses were recorded in 1 of 4 categories ranging from not at all to very regularly. [d] NR [e] To determine if adherence to exercise was associated with characteristics of the individual in or the behaviour of the physical therapist [f] 1681
Terpstra 1992 [37] Musculoskeletal Conditions: Rheumatoid arthritis	[a]No name [b] NR [c] Questionnaire had two sections. One section regarding conducting the exercise programme with 6 questions and the other section about factors that may influence conducting the programme with 11 questions. Face validity was conducted and the authors attempted to establish applicability [d] means and frequencies were calculated combining the two sections of the questionnaire [e] to establish the degree with which individuals adhered and what factors are associated with adherence to their exercise programmes [f] 104 participants with rheumatoid arthritis
White 2007 [49] Respiratory conditions: Cystic fibrosis	[a] NR [b] NR but developed for this study and based on the Manchester Cystic Fibrosis Compliance Questionnaire. It was also piloted by 2 individuals from the target population who provided feedback which was utilised [c] Consisted of three sections; background; adherence to airway clearance; and, adherence to exercise programmes. It was conducted as an interview with a physiotherapist [d] NR [e] To establish the level of adherence in the target population and determine factors that increased or decreased levels of adherence [f] 57 participants with cystic fibrosis

2b. Log based measures of adherence

Author and Condition	[a] Log/ Diary name [b]how devised, [c]description of measure, [d]how scored, [e] purpose of study, [f] number of participants and population, NR= not reported
Alewijnse 2003 [51] Genitourinary conditions: Urinary incontinence	[a]7- day diary [b] NR [c] Participants were asked to report the number of days during the week that the participants had carried out the exercises as per the physiotherapist's instructions. They were asked to report this on a 5 point scale with the first three response options in regards to non-adherence, the fourth option in regards to moderate adherence and the final option in response to ideal levels of adherence [d] NR [e] To identify long term predictors of adherence in the target population [f] 192 participants with urinary incontinence
Alexandre	[a] NR but referred to as a diary

2002 [15] Musculoskeletal Conditions: Low back pain	[b] NR but physical therapists had input into the adherence rating categories [c] The diary recorded exercise frequency each week. Adherence was rated between 0-2 A rating of 2 was someone who was highly adherent and the individual completed 80% of the prescribed exercise, a rating of 1 was a low adherer and the individual had completed less than 80% of the prescribed programme and a rating of 0 was the rating for an individual who was not adherent [d] The diary score was summed with a score for attendance at a clinic session and score for using an educational videotape to obtain an overall adherence score [e] To examine if a number of factors such as demographics, quality of life, barriers in regards to completing the treatment and depression among others were able to predict the adherence of the individual to the programme. [f] 120 participants with back pain
Borello-France 2008 [53] Genitourinary conditions: Stress urinary incontinence	[a] NR but referred to as Exercise Diary [b] NR [c] The diary was used to record exercise sessions that were carried out each week [d] scored as a percentage which was obtained by dividing the number of exercise sessions conducted as reported in the diary by the number of exercises sessions that were prescribed [e] To assess quality of life and continence after a six month intervention and to determine the effectiveness of maintaining the exercise programme over the follow up [f] 28 female participants with urinary incontinence
Brovold 2012 [58] Older People: Activity	[a] NR but referred to as Exercise Log [b] NR [c] Log recorded various activities frequency and duration providing the duration was more than 10 minutes. [d] The mean of reported activities conducted each week was calculated [e] To assess the effects of an exercise and counselling intervention on HRQL and physical ability [f] 108 participants in adults over 60
Chen 1999 [18] Musculoskeletal conditions: Physiotherapy patients	[a] NR but referred to as self-report and follows a log format [b] NR but designed for study [c] The log recorded each exercise conducted, the number of times the exercise was repeated in the session and the number of sessions that were recommended by therapists to do each day. Also recorded were the frequency and duration of exercise sessions in addition to the number of exercise sessions conducted typically per day during the week [d] Percentages were calculated comparing the number of exercise sessions actually completed to the participants recollection of prescribed exercise sessions and to the actual prescribed amount [e] To examine predictive factors for increased adherence and satisfaction to exercise programmes conducted at home

	[f] 62 participants with upper extremity impairment
Cockram 2006 [47] Respiratory conditions: Pulmonary rehabilitation	[a] NR [b] NR [c] Standardised questions used (not reported) to record the type and frequency of exercises carried out at home in addition to any attendance at exercise classes and other physical activity. [d] NR [e] To outline referral and uptake patterns to rehabilitation and the benefits of the rehabilitation in individuals participating in maintenance programmes in a community setting [f] 21 participants undergoing pulmonary rehabilitation
Donesky-Cuenco 2007 [48] Respiratory conditions: COPD	[a] NR but referred to as a daily log [b] NR [c] Recorded the length of time, number of walks along and level of dyspnea after each walk per day [d] dependent on the number of walks conducted compared with the number prescribed, participants were separated into seven categories of adherence [e] To examine behaviour and adherence in regards to the exercise treatment and to validate the adherence categories [f] 103 participants with Chronic Obstructive Pulmonary Disease
Duncan 2002 [38] Cardiovascular conditions: Heart failure	[a]NR but referred to as an exercise diary [b] The targets for the participants to meet in terms of exercise frequency etc were written in the diaries for the participants to conduct unsupervised [c] the diaries recorded the duration and frequency of the prescribed exercises in addition to the type of exercise carried out and an RPE [d] Adherence was measured by a percentage, dividing the number of exercise sessions carried out by the number of sessions prescribed. [e] To evaluate the efficacy of the adherence intervention [f] 13 participants with heart failure
Ettinger 1997 [20] Musculoskeletal conditions: Osteoarthritis	[a]NR but referred to as an exercise log [b] NR [c] The log recorded the frequency and duration of the exercises. [d] Adherence was calculated as a percentage based on the number of exercise sessions completed compared to the number of exercise sessions prescribed [e] To evaluate the effect exercise programmes have on self-reported disability for the target population [f] 439 participants aged 60 years and above with knee osteoarthritis
Fukuoka 2011 [67] Sedentary lifestyles: Activity program for Sedentary Women	[a] Daily Mobile phone diary [b] NR [c] The log was completed every evening between 7pm-12am. It recorded the frequency, intensity and duration of physical activity carried out and the number of steps taken that day and if they wore the pedometer as they were supposed to for the study [d] adherence was calculated by dividing the number of diary entries

	over a month by 21 days resulting in a percentage [e] To assess adherence to pedometer and diary use and the congruence between the steps taken as reported in the diary and the steps recorded by the pedometer [f] 41 sedentary female participants
Gary 2011 [40] Cardiovascular conditions: Heart failure	[a] NR but referred to as a Step/ chord calendar [b] NR [c] Recorded adherence to resistance exercises. The number of exercises carried out, the number of repetitions and Thera-chord colour were all recorded each week which was then collected by nurse or exercise specialist and inputted onto the log sheet. [d] 2 resistance exercise sessions had to be recorded on the calendar in addition to another exercise session recorded differently to be deemed adherent [e] To examine the outcome of the exercise programme on the participants physical function [f] 24 participants with heart failure
Hardage et al, 2007 [60] Older people: Activity	[a] NR but referred to as a daily home exercise log [b] NR [c] Days where participants exercised, an 'E' was marked on the calendar log. If participant had a fall they marked an 'F' to detract from the variable of adherence [d] Individuals were rated adherent if exercise was conducted three times a week [e] To produce a questionnaire to predict adherence to home based exercise programmes [f] 50 participants aged 65 years old and over
Khalil 2012 [50] Neurological conditions: Huntington's Disease	[a] NR but referred to as an exercise diary [b] NR [c] The log recorded which exercises were carried out each week between one and three times. [d] NR [e] To examine how individuals with Huntingdon's Disease and their carers perceived and used a specially developed exercise DVD [f] 15 participants with Huntington disease
King 1991 [68] Sedentary lifestyles: Activity program	[a] NR but described as an exercise log [b] NR [c] The log recorded the type of exercise carried out, the frequency and duration of exercise, heart rate while exercising and an RPE was recorded for each exercise session [d] an adherence score was calculated each month by expressing the number of sessions completed as a percentage of the number of sessions that were set for the 4 week period [e] to examine how effective group based exercise training was in comparison to home based training at high and low intensities [f] 357 participants leading a sedentary lifestyle between the ages of 50 and 65

King 2012 [42] Cardiovascular conditions: Stroke	[a] NR but referred to as diaries [b] NR but reference to Bassett 2003 commenting self-report measures are a good technique to assess adherence [c] Recorded frequency and duration of sessions. Participants were aware sessions must be less than 90 minutes. [d] NR [e] To assess the potential of using computer games in the target population for therapy [f] 3 participant who were recovering from a stroke
Lyngcoln 2005 [63] Surgery: Distal radius fracture	[a] NR but referred to as a home exercise diary [b] NR [c] Recorded the number of exercise sessions the participant carried out and the number of exercises conducted per session [d] A percentage was calculated based on the number of exercise sessions completed compared to the number of exercise sessions prescribed [e] To study the association between adherence to the prescribed exercise and the outcome [f] 15 participants with distal radius fracture
Mannion 2009 [25] Musculoskeletal conditions: Chronic low back pain	[a] NR but referred to as a daily exercise diary [b] NR [c] The log recorded the frequency with which the exercises were completed [d] A percentage was calculated based on the number of exercise sessions completed compared to the number of exercise sessions prescribed [e] To observe how adherence influences self reported disability and pain scores and to establish factors that may influence adherence [f] 32 participants with chronic low back pain
Mori 2006 [57] War veterans: Gulf war veterans illness	[a] NR but referred to as a daily log [b] NR [c] The frequency, intensity and duration of exercise were recorded. In addition the participants had to report as to how they had measured the exercise intensity from the choice of; heart rate, METs or RPEs [d] NR [e] To examine predictors of exercise adherence for the condition of the target population [f] 531 participants with Gulf War Veterans illness
Oka 2000 [44] Cardiovascular conditions: Heart failure	[a] NR but referred to as an activity log [b] NR [c] The logs were filled in daily and recorded RPE, heart rate, exercises completed and the duration of the exercises, and any symptoms that occurred [d] A percentage was calculated based on the number of exercise sessions completed compared to the number of exercise sessions prescribed [e] To assess the outcome of a home based exercise programme on

	levels of fitness, quality of life and symptoms in the population of interest [f] 40 participants with heart failure
Pickett 2002 [14] Cancer: Breast	[a] NR but referred to as a daily diary [b] Devised by authors and used in previous studies but not measuring adherence. Content validity was attempted by a panel of oncology nurses and nurse researchers and exercise physiologists. No target population input. [c] The diary recorded fatigue, duration of walking, pulse rate before and after walking in addition to any side effects or symptoms of disease experienced [d] NR [e] To observe adherence patterns to the exercise programme and examine if the disease of the target population or side effects from the treatment affect the levels of exercise completed. In addition to propose other methods that could improve future studies examining moderate intensity exercise in comparable groups to the target population [f] 52 participants breast cancer recently diagnosed
Saez 2004 [32] Musculoskeletal conditions: Injured athletes	[a] NR but referred to as a personalised record sheet [b] designed by the authors for the particular individual factoring in the rehabilitation programme suggested by the doctor [c] Content of sheet regards rehabilitation recommended for individual participant by doctor and is completed each week [d] Adherence throughout the study was established by determining a weekly mean to calculate an overall mean for adherence [e] To examine psychological responses and the impact they have on the recovery of the participant [f] 20 participants with injuries sustained via football
Salo 2012 [33] Musculoskeletal conditions: Chronic neck pain	[a] NR but referred to as exercise diaries [b] NR [c] Recorded how often an exercise session took place, which exercises were conducted, the repetitions of the exercises and weights used. [d] A mean and standard deviation of the training frequency was calculated [e] To assess if exercises for the target population can increase HRQL [f] 101 participants with neck pain
Schoo 2005 [34] Musculoskeletal conditions: Osteoarthritis	[a] NR but referred to as a diary and log sheet [b] taken from pre-existing diary recording wet episodes in incontinence patients [c] Recorded how many exercises- as in all, some or none- had been carried out each day [d] A percentage was calculated regarding how much of the exercise programme was performed. [e] To determine factors related to exercise programme adherence [f] 90 participants with osteoarthritis over the age of 60

Spink 2012 [61] Older People: Podiatry/ falls	[a] NR but referred to as a daily exercise diary [b] NR [c] Recorded the frequency with which the exercises were carried out. [d] Adherence was deemed as the participant reporting 50% or more of the prescribed exercise being completed [e] To examine adherence, predictors of adherence and barriers to the intervention in the target population [f] 153 participants aged 65 years and over that are prone to falling
Steinhilber 2012 [36] Musculoskeletal conditions: Osteoarthritis	[a] NR but referred to as exercise logs [b] NR [c] Recorded frequency and duration of exercise in addition to pain and exertion experienced whilst conducting the exercises. [d] Adherence was measured by comparing the number of exercise sessions conducted compared to the number of sessions prescribed [e] To add a home based exercise programme to a pre-existing group based exercise session and to discover if it can be conducted by the target population [f] 36 participants with osteoarthritis of the hip or have had a hip replacement
Tooth 1993 [46] Cardiovascular Conditions: Myocardial Infarction	[a]NR but referred to as a log book [b] NR [c] the logs recorded the duration and frequency of exercises per week [d] Frequency and duration of exercise completed was summed and compared to the amount of exercise prescribed [e] To explore if certain characteristics at baseline could be predict participants adherence to the exercise programme [f] 30 participants that have suffered a myocardial infarction
Wang 2012 [69] Sedentary lifestyles: Weight loss	[a] NR but referred to as diaries [b] NR [c] the logs recorded the frequency of the exercise providing it was more than twice a week and the duration of the exercise providing it was a minimum of 30 minutes [d] NR [e] To discern the effectiveness of self- reported logs for weight loss in the target population [f] 50 chronically ill obese participants
Wilbur 2001 [70] Sedentary lifestyles: activity programme for sedentary healthy women	[a] NR but referred to as exercise logs [b] NR [c] The logs recorded date, if they completed the warm up and cool down properly and in entirety, the duration of time spent walking and estimated number of miles walked. Participants were encouraged to note weather, terrain, route taken, and how the participant felt whilst walking. [d] NR [e] To exhibit the used of an exercise log in conjunction with a heart rate monitor to measure adherence to prescribed exercise in addition to recommending a different way to describe adherence to an exercise

	programme that reflects the process of behaviour change [f] 156 female participants leading sedentary lifestyles
Zagarins 2011 [65] Surgery: Bariatric surgery patients	[a]NR but referred to as a weekly exercise log [b] NR [c] the logs recorded the frequency and duration of the exercise sessions, the type of exercise performed, Borg scale rating during exercise and data pertaining to pedometer use per week [d] means and standard deviations were calculated from the results [e] To assess adherence and evaluate the efficacy of an exercise programme [f] 46 participants who have undergone bariatric surgery

2c. Visual Analogue Scale (VAS) based measures of adherence

Author and Condition	[a] VAS name [b]how devised, [c]description of measure, [d]how scored, [e] purpose of study, [f] number of participants and population, NR= not reported
Michener 2001 [28] Musculoskeletal conditions: Physiotherapy patients	[a] NR but was a VAS [b] NR [c] 14.5cm long line with percentages 0, 25, 50, 75 and 100% marked on the line to anchor it. [d] The mark on the line from the participant measuring their percentage adherence was converted into cm [e] To establish if grip strength recovery was related to work performance and functional results after completing occupational therapy [f] 15 participants with hand trauma
Roddey 2002 [31] Musculoskeletal conditions: Physiotherapy patients	[a] NR but was a VAS [b] NR [c] a 10 cm line with the anchors at each end regarded completing no exercise to completing all exercises for the week. A mark was then made on the line to denote the participants adherence levels [d] Adherence was assessed depending on the number of VAS' returned to the researchers by the participant and the level of adherence they had indicated [e] To evaluate the success of a video tape intervention as opposed to a physical therapist providing instruction on adherence to home based exercises and the outcome of individuals in the target population [f] 108 participants following Rotator Cuff repair surgery

2d. Other based measures of adherence

Author and Condition	[a] measure name [b]how devised, [c]description of measure, [d]how scored, [e] purpose of study, [f] number of participants and population, NR= not reported
van Leer 2012 [66] Vocal: Voice therapy	b[a] Tally counter [b] NR [c] A small devise that the participant had on their person to record each time the exercises were performed for at least a 2 minute duration. This form of monitoring adherence was conducted for the 1st 2 weeks and data was obtained at 3 time points during these 2 weeks [d] NR [e] To assess if adherence and motivation can be enhanced by interventions put In place (support for practice using mobile videos) [f] 14 participants undergoing voice therapy

Appendix 3. Table displaying the evaluated Psychometric Properties of all measures included in the systematic review

					reproducibility				
Author and year	content validity	internal consistency	criterion validity	construct validity	agreement	reliability	responsiveness	floor and ceiling	interpretability
Alewijnse 2003 [51]	0	0	0	?	0	0	0	0	?
Alexandre 2002 [15]	-	0	0	?	0	0	0	0	0
Barnowski 1998 [62]	0	0	0	?	0	0	0	0	?
Bassett 2011 [16]	0	?	0	?	0	0	0	0	?
Bennell 2012 [17]	0	0	0	0	0	0	0	0	0
Borello-France 2008 [53]	-	0	0	0	0	0	0	0	0
Borello-France 2010 [52]	0	0	0	0	0	0	0	0	0
Brovold 2012 [58]	0	0	0	0	0	0	0	0	0
Chen 1999 [18]	0	0	0	?	0	0	0	0	0
Chen 2009 [54]	?	?	0	0	0	0	0	0	0
Cockram 2006 [47]	0	0	0	0	0	0	0	0	0
Courneya 2004 [13]	0	0	0	?	0	0	0	0	0
Dobkin 2008 [19]									
GAS	0	0	0	?	0	?	0	0	?
SAS	0	0	0	?	0	0	0	0	?
Donesky-Cuenco 2007 [48]	0	0	0	?	0	0	0	0	?

Duncan 2002 [38]	0	0	0	0	0	0	0	0	0
Ettinger 1997 [20]	0	0	0	0	0	0	0	0	0
Evangelista 2001 [39]	+	?	0	?	0	0	0	0	0
Forkan 2006 [59]	?	0	0	0	0	0	0	0	0
Fukuoka 2011 [67]	0	0	0	?	0	0	0	0	0
Gallo 1997 [55]	?	0	0	0	0	?	0	0	0
Gary 2011 [40]	0	0	0	0	0	0	0	0	?
Hardage 2007 [60] AESOP Monthly calendars	 + 0	 0 0	 ? 0	 - 0	 0 0	 ? 0	 0 0	 - 0	 0 0
Howard 2008 [21]	?	0	0	?	0	0	0	0	?
Jurkiewicz 2011 [41]	0	0	0	0	0	0	0	0	?
Khalil 2012 [50] Telephone questionnaire Log	 0 0	 0 0	 0 0	 0 0	 0 0	 0 0	 0 0	 0 0	 0 0
Kim 2006 [56]	0	0	0	0	0	0	0	0	?
King 1991 [68]	0	0	?	?	0	0	0	0	?
King 2012 [42]	0	0	0	0	0	0	0	0	0
Levy 2008 [22]	0	?	0	-	0	0	0	0	?
Levy 2008 [23]	0	?	0	-	0	0	0	0	?

Lyngcoln 2005 [63]	0	0	0	?	0	0	0	0	0
Lysack 2005 [64]	0	0	0	0	0	0	0	?	0
Mailloux 2006 [24]	0	0	0	0	0	0	0	0	?
Mannion 2009 [25]	0	0	0	?	0	0	0	0	0
Marzolini 2010 [43]	-	0	0	0	0	0	0	0	0
McCarthy 2004 [26]	0	0	0	0	0	0	0	0	0
Medina-Mirapeix 2009 [27]	0	0	0	0	0	0	0	0	0
Michener 2001 [28]	-	0	0	0	0	0	0	0	0
Milne 2005 [29]	0	0	0	0	0	0	0	0	0
Mori 2006 [57]	0	0	0	?	0	0	0	0	0
Oka 2000 [44]	0	0	0	0	0	0	0	0	0
Pickett 2002 [14]	-	0	0	0	0	0	0	0	0
Rackwitz 2007 [30]	-	0	0	0	0	0	0	0	0
Radtke 1989 [45]	-	0	0	?	0	0	0	0	0
Roddey 2002 [31]	0	0	0	0	0	0	0	0	?
Saez 2004 [32]	-	0	0	0	0	0	0	0	0
Salo 2012 [33]	0	0	0	0	0	0	0	0	0
Schoo 2005 [34]	-	0	0	0	0	0	0	0	?

Sluijs 1993 [35]	0	0	0	?	0	0	0	0	?
Spink 2012 [61]	0	0	0	0	0	0	0	0	0
Steinhilber 2012 [36]	0	0	0	0	0	0	0	0	0
Terpstra 1992 [37]	?	0	0	0	0	0	0	0	0
Tooth 1993 [46]	0	0	0	0	0	0	0	0	0
van Leer 2012 [66]	0	0	0	0	0	0	0	0	0
Wang 2012 [69]	0	0	0	0	0	0	0	0	0
White 2007 [49]	?	0	0	0	0	0	0	0	0
Wilbur 2001 [70]	0	0	?	0	0	0	0	0	0
Zagarins 2011 [65]	0	0	0	0	0	0	0	0	0

Key

The criteria the construct needed to obtain to get a certain rating varied greatly as each aspect was different. Therefore please see [15] for the criteria needed for each construct for the different ratings.

+= A positive rating where the paper and measure have addressed each of the criteria for a positive rating to a satisfactory extent

?= An intermediate rating where the paper and measure have possibly completed some of the aspects needed for a positive rating, but not all of the required aspects or the method or design used is doubtful

-= A negative where the aspect being measured proved to be non-existent or fall below specified thresholds despite the method and design used were sufficient

0= A 0 was accredited when there was no information in the paper or evident in the measure that this aspect had been considered.

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3-4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	3-4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	N/A
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	4-5
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Appendix 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	N/A
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	5-7 and Appendix 3
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	7
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	7-8
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	8-9
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	9

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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